

# M A C H I N E

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

# D E S I G N

Volume 11

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Number 3

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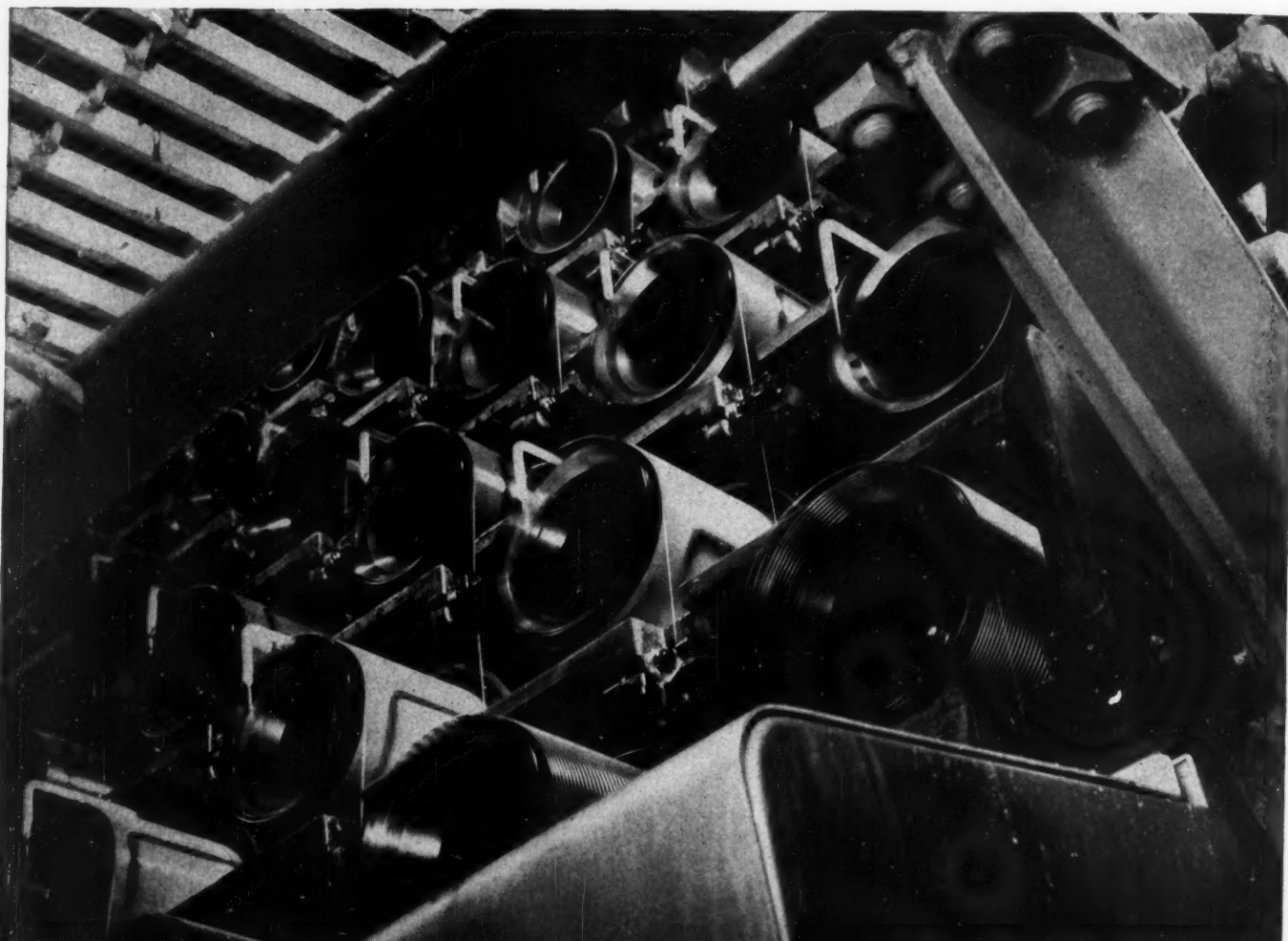
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## Now it's Rayon by the MILE in a new continuous process

### Another New Development Aided by New Departure

● Engineering by New Departure assisted the Rayon Machinery Corporation in development of machines for the first continuous process viscose rayon plant built by Industrial Rayon Corporation at Painesville, Ohio.

Over 100,000 reels and spindles will turn on more than 300,000 New Departure Ball Bearings.

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## NEW DEPARTURE Ball Bearings

*New Departure • Division General Motors Corporation • Bristol, Connecticut*

**NOTHING ROLLS LIKE A BALL**

# Itemized Index

CLASSIFIED FOR CONVENIENCE WHEN STUDYING SPECIFIC DESIGN PROBLEMS

KEY: EDIT., EDITORIAL PAGES; ADV., ADVERTISING PAGES; R, RIGHT-HAND COLUMN; L, LEFT-HAND COLUMN

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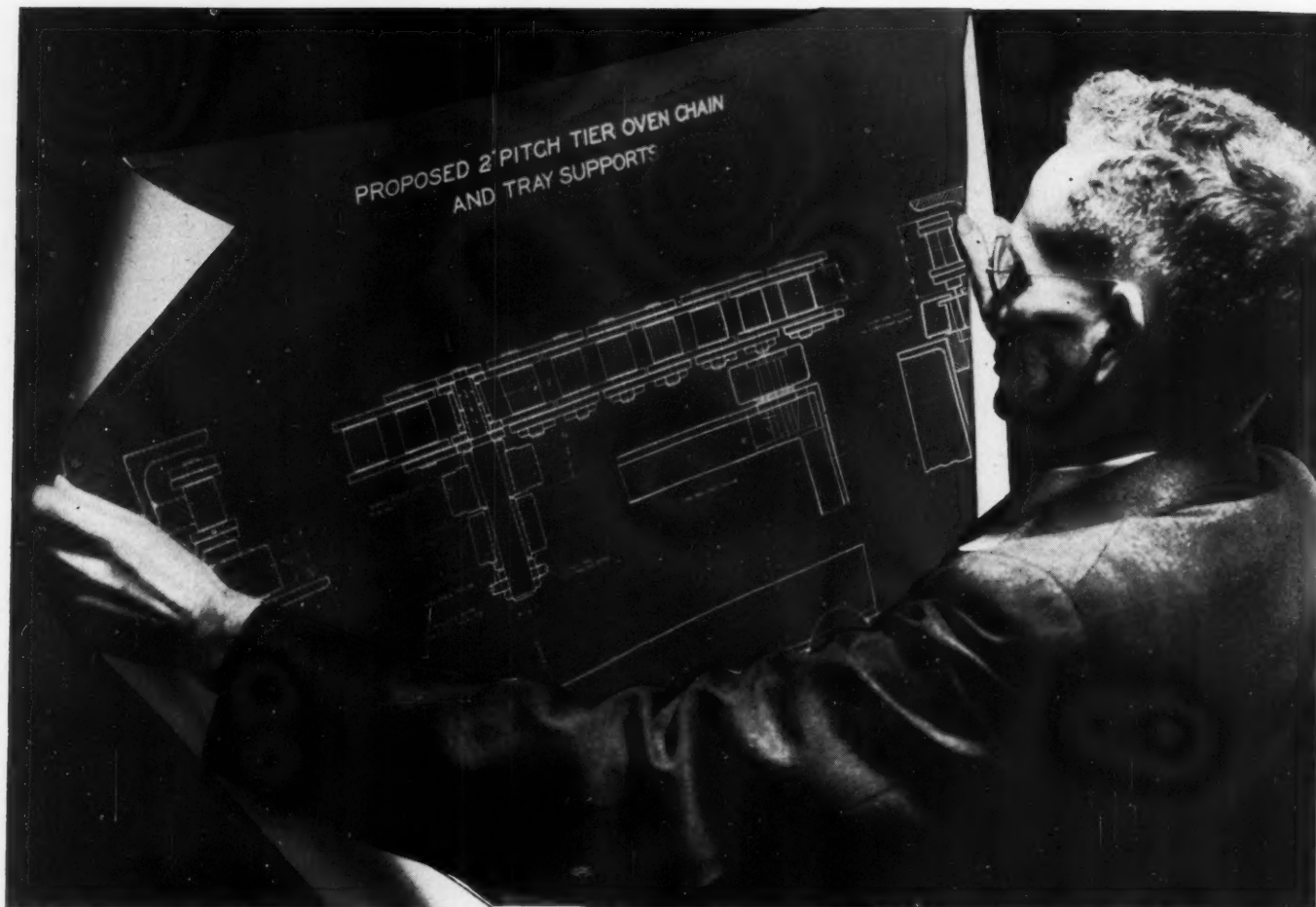
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## Design for Better Biscuits



### Take Your Cue from the Bosun's Crew

In the days of wooden ships and iron men every bit of muscle had to count. Today, positive roller chain and sprocket drives are the modern application of the bar-in-capstan idea for conditions where power waste is taboo.

Diagramed here is a case where intelligent cooperation between Baldwin Roller Chain engineers and a nationally known biscuit company worked out the solution of a troublesome problem. Results: Better baked biscuits for the tables of the land—at a lower manufacturing cost.

An important factor in designing any machine is to know which particular type of drive is best suited for the job. We know and can demonstrate to you how modern Baldwin Roller Chain has set new standards by its strength, high speeds, long life, resistance to heat, dust, dirt and corrosion.

By putting our heads together we can do for you what we did to make better biscuits. Why not call the B-D Man today?

**BALDWIN-DUCKWORTH CHAIN CORPORATION**

SPRINGFIELD, MASSACHUSETTS  
Factories at Springfield and Worcester, Mass.



**Present  
Users  
Proved  
the  
Point**

**UNBRAKO**



Fig. 1645  
Pat. App. for

*Proved conclusively that the "UNBRAKO" Set Screw cannot loosen up in service ... that the ingenious knurling around the cup point locks the screw securely when it's merely tightened in the ordinary way. Proved: "We've got something here!"*

## SELF-LOCKING HOLLOW SET SCREWS

• Knurled Points •

To avert accidents and prevent breakdowns caused by set screws loosening up, you should, by all means, use the new "UNBRAKO" Set Screws with the Self-Locking Knurled Point. Once set up, it cannot fail to hold, yet it can be removed for adjustments and reused again and again.

It's a real answer to breakdown problems ... proved by usage in many different plants and under varied conditions.

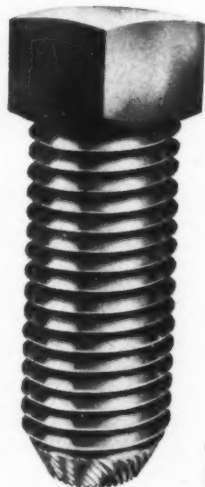


Fig. 1646  
Pat. App. for

**Knurled  
Point  
on the**

**UNBRAKO**

**Self  
Locking  
Square-Head  
Set Screw,  
too!**

The Square-Head Set Screws used and liked by industry for years also can be had now with the automatic self-locking feature provided by the knurled cup points. And, like the Knurled Point Set Screw, they hold tight—yet are easily removed with ordinary tools, and used over and over again.

**Get Bulletin!**

And, that is why we say you're passing up a good bet if you fail to get the "UNBRAKO" samples and detailed information that are yours freely for the asking. The coupon below brings them to you; rip it out and mail it NOW!

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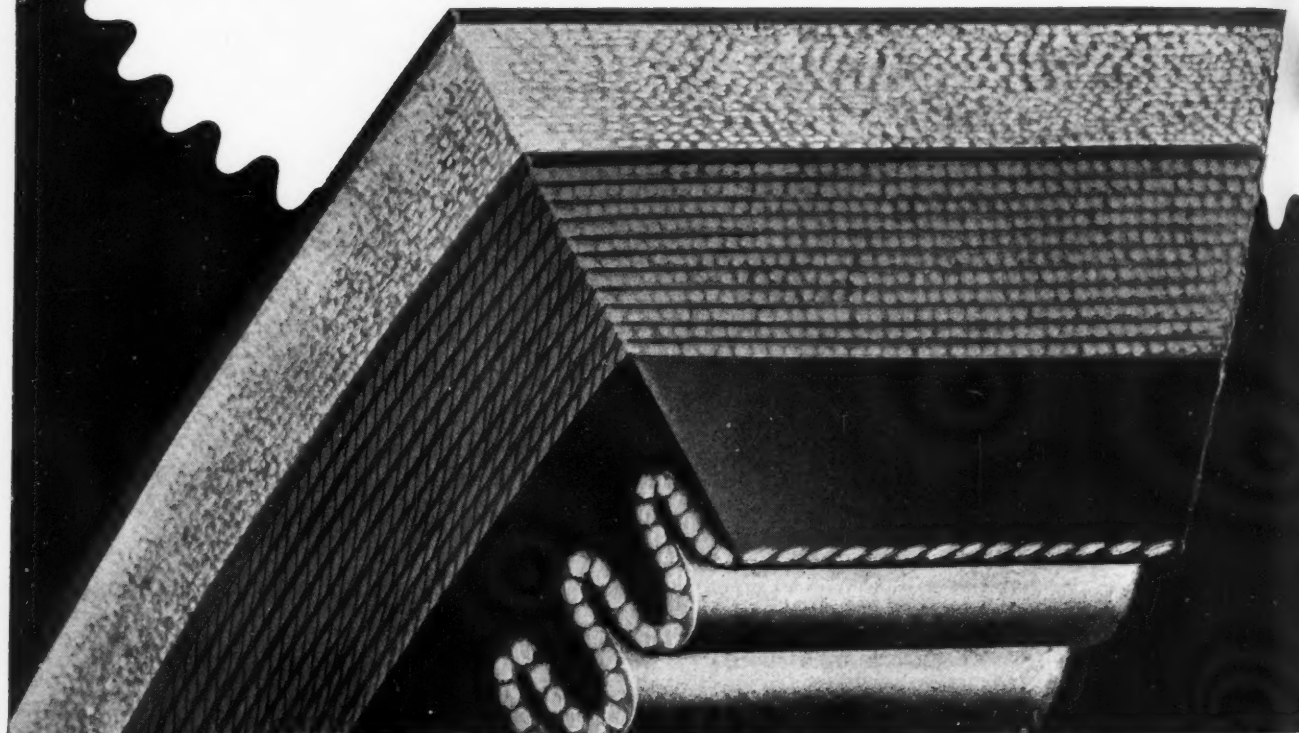
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# *From the Research Lab*

THE WORLD'S LARGEST MAKER OF V-

## **IMPROVED** *Super-Flex* Dayton Cog-Belt



Outstanding in Basic Scientific Design—the Improved Super-Flex Dayton Cog-Belt with Daytex Cord Gives You These **EXCLUSIVE** Advantages of Cooler Running, Longer Life



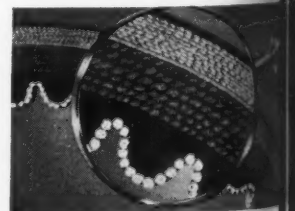
### **Built to Bend**

In Dayton's convolute layer construction the entire belt is built to bend—less internal strain—longer life. And because of the cross-wise rigidity, Dayton Cog-Belts ride true in the pulley grooves. No twisting—no distortion—cooler running, longer life.



### **Patented Cog Construction**

Dayton's patented cogs close up when the belt goes around the pulley—and take up the compression on the inside of the belt. Another reason why Super-Flex Dayton Cog-Belts are more flexible—cooler running and longer lasting.



### **Greater Gripping Power**

Because of their die-cut sides Dayton Cog-Belts have greater gripping power—the highest coefficient of friction of any belt.

Research Laboratories of

THE MAKE OF V-BELTS COMES THIS

# DAYTON COG-BELT WITH DAYTEX CORD

In millions of applications, Dayton Cog-Belts have established remarkable records for long life—for the delivery of smooth, silent, constant driving power at low cost. Now, Dayton, the pioneer in the latexing of cord for V-Belts, brings you another revolutionary development—the improved Super-Flex Cog-Belt made with Daytex Cord.

#### Cooler Running

Cooler running because it defeats life destroying internal heat, this improved Super-Flex Dayton Cog-Belt with Daytex Cord is the result

of 7 tireless years of tests and research by Dayton's famed technical laboratories. This long-lived Daytex Cord—with inter-locked non-slip fibres—latex processed by exclusive patented Dayton equipment—sets an entirely new standard of strength and compactness—it's a cord with minimum stretch—a cord with super-flexibility.

#### Longer Life—Fewer Adjustments

Today, this compact, Super-Flex, stronger Daytex Cord in the neutral section of Dayton V-Belts sets a new standard of long-lived power

transmission. The improved Super-Flex Dayton Cog-Belts last longer than ever before. Maintenance costs are still lower because fewer adjustments are necessary! No slip—no stretch. These Super-Flex Daytons deliver positive, dependable, shock-proof power.

Learn first-hand what this improved Super-Flex Dayton V-Belt can mean to you in increased production with lower cost. Write for the facts today.

THE DAYTON RUBBER MFG CO.  
DAYTON, OHIO



Whether for fractional or a thousand horsepower—there is a Dayton V-Belt Drive for the job.

*Super-Flex*  
**Dayton**  
COG-BELT DRIVES  
WITH DAYTEX CORD

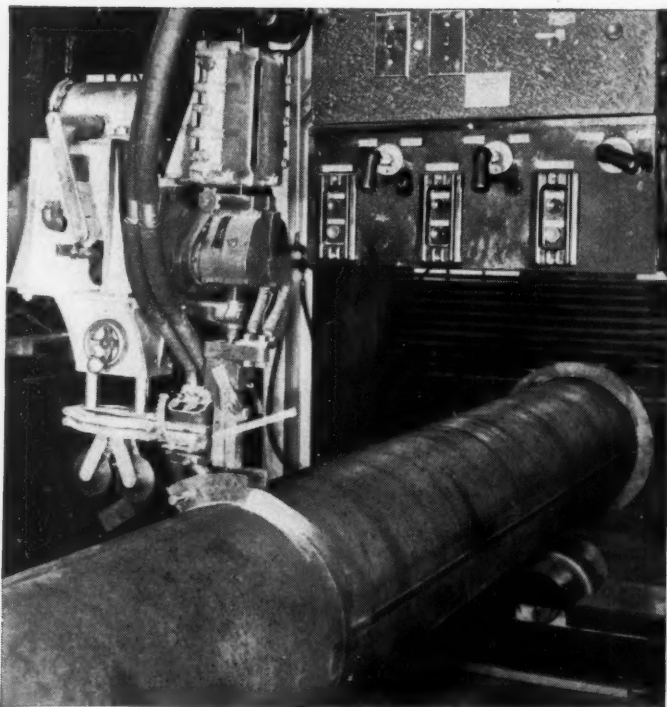
MADE BY THE WORLD'S LARGEST



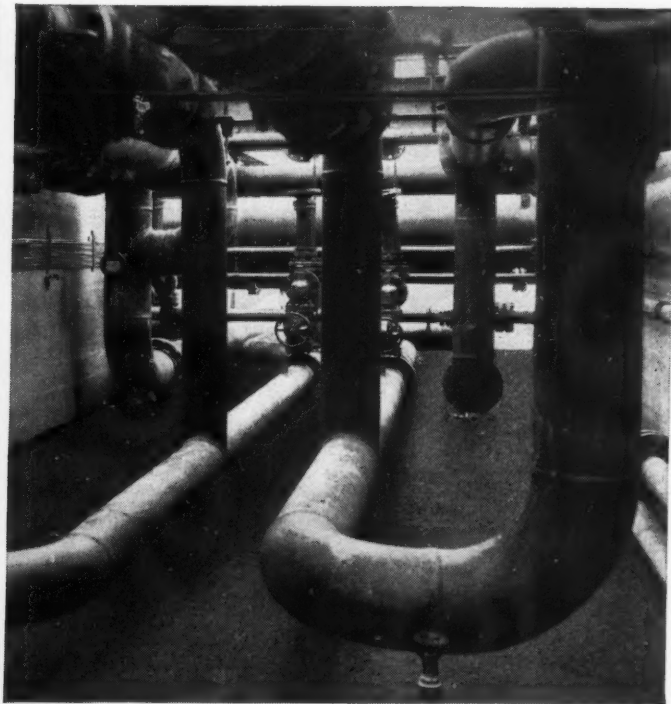
MANUFACTURER OF V-BELTS

# More Power to You

*New Linde processes for fabricating pressure vessels and for joining pipe assure long, dependable service*

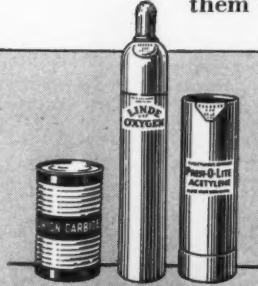


**UNIONMELT WELDING:** A speedy, dependable, automatic welding process is now available in Unionmelt Welding—an electric welding process—which is shown here making a girth weld on a Par. U-68 (Class 1) type pressure vessel. This vessel has a wall thickness of 5/16 inch, and the weld was made in one pass at 19 inches a minute. Unionmelt welds have met the rigid specifications of the A.S.M.E. code for fired power boilers and of Par. U-68 (Class 1) for high-test type pressure vessels, and have been accepted by various insurance and inspection organizations.




**LINDEWELD MULTI-FLAME PROCESS:** Strong and tough welds of uniformly high quality can be obtained when piping systems are joined by the Lindeweld Multi-Flame Process which employs the new Oxweld 6- and 4-flame welding tips and high-speed welding rod. These welds, properly made, are permanently leak-proof and require no further attention. Also, they are ductile and are as corrosion-resistant as the pipe base metal. The Lindeweld Multi-Flame Process is fast and consumes a minimum of oxygen and acetylene in the installation of piping systems.

Many economical applications of these new Linde processes can be utilized by power consuming industries. Any Linde representative will gladly discuss them with you. Write the nearest Linde office for further information.



## THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

New York and  Principal Cities

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### Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE

The words "Linde," "Prest-O-Lite," "Oxweld," "Lindeweld," "Union" and "Unionmelt" are trade-marks of Units of Union Carbide and Carbon Corporation.

You can see demonstrations of machine-cutting, including the Oxweld CM-15 Cutting Machine—flame-hardening—and the welding of oil well casings with the new Oxweld multi-flame tips—at the Linde exhibit, Area 109-115, Oil-World Exposition, Houston, Texas, April 24-29, 1939.



# The Story of the Puzzling Pump

AND HOW DU PONT NEOPRENE HELPED  
TIMKEN MAKE IT FOOLPROOF

A FEW YEARS AGO, the Executive Engineer of a leading machine parts manufacturing concern was making an inspection trip through a branch factory when he was hailed by a group of men in a corner of the power house.

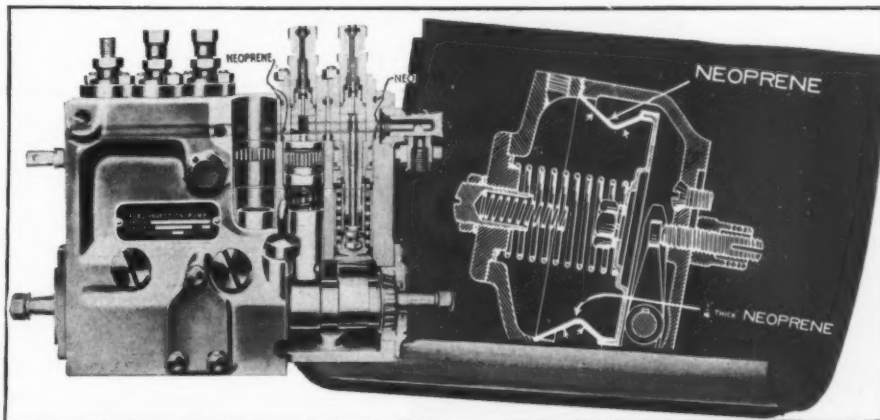
"Come take a look at this sick diesel fuel injection pump," they said. "Can we fix it, or shall we just take it out and give it a decent burial?"

The Executive Engineer looked at the pump and scratched his head. You know what he was up against . . . for in those days a fuel injection pump was as complicated as a Chinese puzzle.



"Boys," he said finally, "you've got me. Better wire the people who made it. And I'm going to see what I can do about getting a simplified yet efficient pump."

He did. Others did too. And that's what led the Timken Roller Bearing



Company to design a fuel injection pump so simple and reliable that almost any mechanic could understand it. In this new pump the number of separate parts was minimized. Whole sections were made easily replaceable.

One of the factors which made this improved pump possible is the unique performance of neoprene, Du Pont's chloroprene rubber, in the presence of oil and heat. Neoprene sealing units are used extensively . . . in the mechanical governor, in the center shoulder of the pumping unit, on the control shaft, and in many other places. In the vacuum-type governor, too, neoprene is an important part of the bellows and diaphragm assembly.

So, thanks in part to neoprene, fuel

injection pumps are available that aren't necessarily puzzling... one of the thousands of cases where neoprene has helped solve design problems. We hope that this story will suggest ways in which neoprene can be useful to you too. Keep abreast of new uses of neoprene by writing for your subscription to the free, monthly, newsy "Neoprene Notebook."



## NEOPRENE

E. I. du Pont de Nemours & Co., Inc.  
Rubber Chemicals Division  
Wilmington, Delaware

# WHY THIS *Twisted* CONNECTING ROD MAKES *Better* ENGINES



Steel Castings that pass tests like this — many times as severe as the demands of actual operation — make better machines. They provide extra strength without useless weight. They have the rigidity that insures permanent alignment, yet they stand sudden shocks and strains.

They save time, because they require less machine finishing. They permit scientific metal distribution. They resist corrosion, wear and fatigue.

## STEEL CASTINGS BRING YOU THESE ADVANTAGES

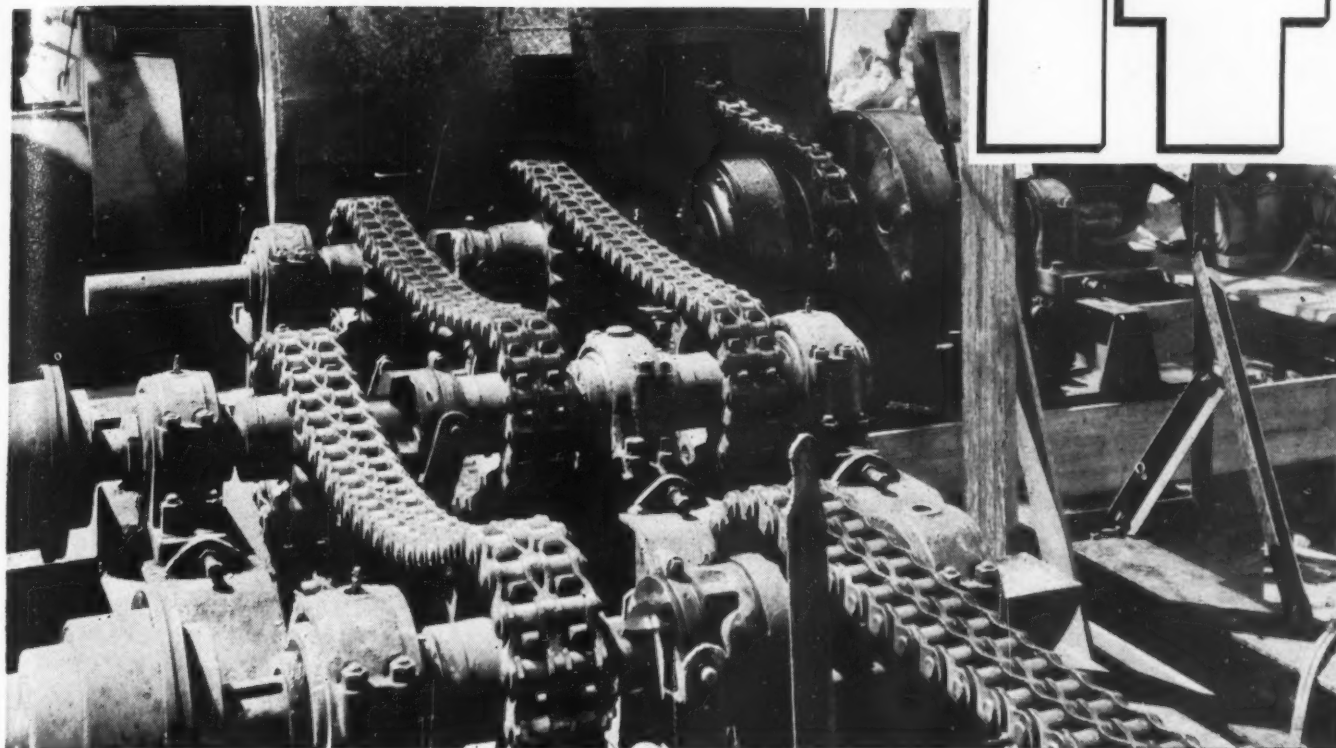
- 1 Uniform structure, for greater strength, shock and stress resistance.
- 2 Metal distributed where it will do the most good; maximum strength with minimum weight.
- 3 Widest range of physical properties.
- 4 Good machining qualities, low finishing costs, better streamlined appearance.
- 5 High rigidity, minimum deflection, accurate alignment, close tolerances and better fit.
- 6 Readily weldable in composite structures.
- 7 High fatigue resistance, maximum endurance and longer life — ideal for critically stressed parts.

Steel Castings can make *your* product better, and save you money. Consult your own foundry, or write to Steel Founders' Society, 920 Midland Bldg., Cleveland, Ohio.

**IMPROVE YOUR PRODUCT WITH**

# STEEL CASTINGS

# HOW TO HANDLE



*Rex Chabelco on drilling rigs in the oil fields means lower cost per foot of hole on any well.*

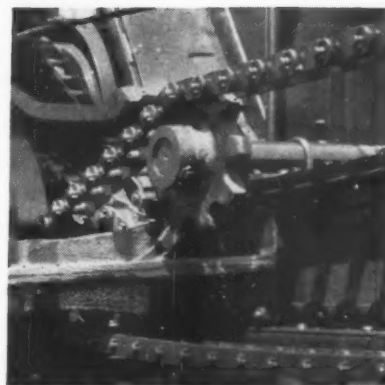
## IF *IT* IS HORSEPOWER



Driving high-speed rotary rigs in the oil field is the toughest, heavy-duty, high-speed work that chain or any other type of transmission equipment is ever asked to do. *Rex Chabelco chains are among the most popular for this service.* They were used in drilling KCL-A2—the world's deepest hole—and are found on rigs the oil world over.

### **Chabelco has what your drives need!**

Wherever economical power transmission is important to profitable operation, Rex Chabelco Chains can be the answer. They have become standard in all types of industries for use on high-powered drives, where starts and stops are frequent, loads are heavy and work is continuous. They are built in all sizes and types. Ask the "How to Handle It Man" which of the Chabelco series will give you the economy and reliable service you want on tough drives.



*Powerful chain crowds, driven by Rex Chabelco Chain, force heavy shovel dippers into toughest soils—a great aid in modern high-speed digging.*

Use this coupon to bring you your copy of "How to Handle It in Every Industry," a folder describing the complete Rex line.

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1643 West Bruce Street, Milwaukee, Wis.  
Please send me my copy of "How to Handle It in Every Industry."

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# REX

**DRIVE AND CONVEYOR CHAINS  
FOR THE MACHINERY INDUSTRY**

**CHAIN BELT COMPANY of Milwaukee**



**CAN YOUR PRODUCT**

**Outsmart**

**ITS COMPETITORS?**



Machines—as well as men—need brains to get along. That's why you find so many manufacturers building into their products "heads for figures"—Veeder-Root Counting and Computing Devices.

Veeder-Root Counting Devices have made many machines practically human. Gasoline pumps use them to do their arithmetic—convert gallons into dollars and cents. Night deposit boxes have them as mechanical tellers—to count, *with accuracy*, deposits. Telephone switch-boards use them to check

the length of calls. And in many other cases Veeder-Root Devices are used to give products more brains—to help them do more—to help them *sell* more. The applications of Counting and Computing Devices are unlimited. Veeder-Root Engineers are constantly working with manufacturers—finding new ways to make products more useful and salable, with built-in counting devices.

It might pay you to see if a Counting Device can help *your* product "out-smart" its competitors.



*Write for the interesting Veeder-Root booklet "Counting Devices"*

It shows many of the unusual applications of Veeder-Root Counting Devices—gives a clear picture of their possibilities—offers ideas that lead to sales.

**VEEDER-ROOT**  
*Counting Devices*

**BUILDERS OF COUNTING DEVICES SINCE 1878**

**VEEDER-ROOT INC.  
HARTFORD, CONN.**

Offices in Boston, Chicago, Cincinnati, Cleveland, Detroit, Greenville, S. C., Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco, Montreal, Buenos Aires, Mexico City, London, Paris, Tokyo, Shanghai, Melbourne

# ASSEMBLY COSTS CUT 50%

*and more by single simple change in screw design*

## PHILLIPS RECESSED HEAD SCREWS REPLACE SLOTTED SCREWS ON FAMOUS MAKES OF MOTOR CARS, ELECTRICAL APPLIANCES, FURNITURE

Production schedules speeded up . . . spoilage eliminated . . . appearance and holding power improved — that's the report from manufacturers who lead the way in adoption of Phillips Recessed Head Screws.

Priced slightly higher, Phillips Screws make such large savings in assembly time, that total production costs are much reduced. Delays and spoilage previously caused by slipping drivers are eliminated by the design of screw head which holds the driver in the recess.

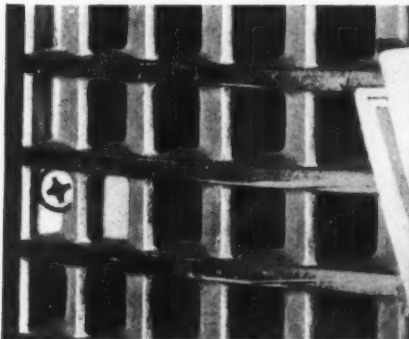
Phillips Screws set up tighter with less effort and without split heads, thus increasing resistance against loosening, decreasing service required.

### 80,000 PHILLIPS SCREWS TO CROSS ATLANTIC

Boeing's new Atlantic Clipper assembled with tighter-holding Phillips Screws.

### DESIGN ENGINEERS SEE SIMPLER FASTENINGS

Leading automotive manufacturer now uses Phillips Screws which do not need locking devices. Counter-sunk finishing washers can also be eliminated.



### More Frequent Use of Power Drivers Due to Patented Phillips Screw

Freedom from threat of a slipping driver means faster driving methods can be used. Many manufacturers now use power drivers on jobs where caution used to demand a slower, more costly method.

Elimination of pilot holes; straight-line driving (leaving one hand free to steady the work); prevention of burrs due to close fit of driver and screw — all contribute to further time savings and better-quality work.

### GENUINE PHILLIPS RECESS . . . THE HEAD CAN'T SPLIT

The taper and depth of the Phillips recess resulted from months of research to determine the shape which would utilize the driver's maximum turning power without sacrifice of strength in the screw head. Four sizes of Phillips Drivers provide greatest efficiency for the entire range of Phillips Screw sizes. Two driver sizes fit diameter #5 to #16 inclusive.

No Screw-Using Plant Can Afford to Miss This Booklet on 1939 Assembly Methods!

Gives you facts on production cost savings in many kinds of industries. Tells you why you can pay the extra price for Phillips Recessed Head Screws — and save up to 50% or more in production cost. Address one of the firms below for a free copy.



# PHILLIPS



## RECESSED HEAD SCREWS

U. S. Pat. on Product and Methods Nos. 2,046,343; 2,046,837; 2,046,839; 2,046,840; 2,082,085; 2,084,078; 2,084,079; 2,080,858

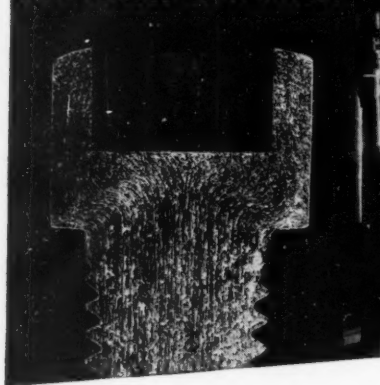
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Chandler Products Company, Euclid, Ohio  
Continental Screw Co., New Bedford, Mass.

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The Lamson & Sessions Co., Cleveland, Ohio  
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IT COSTS LESS TO USE PHILLIPS SCREWS

COLD-FORGED OF PARKALOY



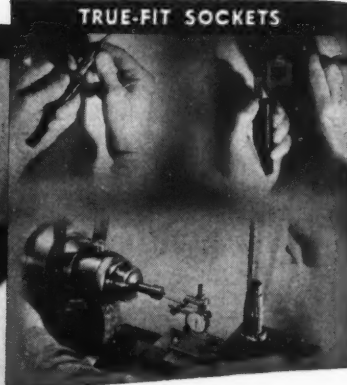
DEPENDABLE UNIFORMITY



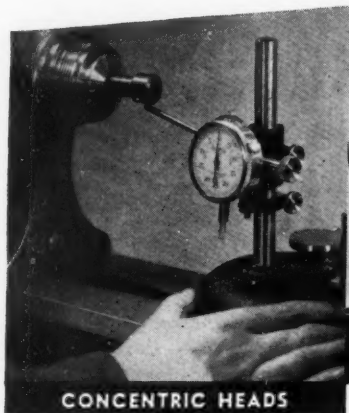
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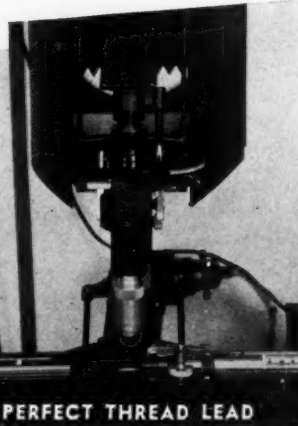
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*Cold-forged*

# **SOCKET SCREWS**



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DOWMETAL is by far the lightest of all structural metals—a full third lighter than aluminum. Its extreme lightness eliminates useless weight, cuts power costs and greatly reduces vibration in reciprocating parts.

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DOWMETAL offers far more than extreme lightness. It has strength, toughness and high resistance to atmospheric exposure. In the widest variety of applications, DOWMETAL is taking shocks, severe strains and heavy loads without complaint. For example, it's used for airplane landing wheels.

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The roll call of products wholly or in part designed of DOWMETAL\* includes a vast portion of the nation's industries. For example, the Woodstock Typewriter Company die-cast the top cover of their typewriter from DOWMETAL. They have cut approximately two pounds of weight from their machine. In addition, DOWMETAL's exceptional machinability has reduced finishing costs.

## IT SLICES PRODUCTION COSTS!

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INDUSTRY'S LIGHTEST STRUCTURAL METAL

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PHOTOGRAPH COURTESY FROMM SILVER FOXES

Only a helical spring washer has *Live Action*!



# Safe

## JOURNEYS END

Helical Spring Washers, at vital parts of the car, guarded her comfort and safety

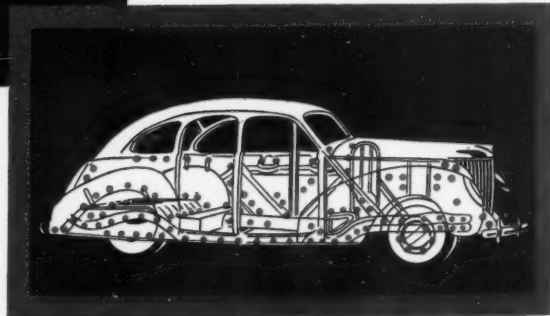
Carefree motor trips are accepted today as a matter of course. But if it were not for the long range *Live Action* of Helical Spring Washers those trips would not be so carefree!

Wouldn't your product give longer service, better customer satisfaction, if bolted parts *remained* tight? Long Range *Live Action* is an exclusive feature of Helical Spring Washers and costs you nothing extra. Be safe...specify only Helical Spring Washers.

An average of 746 Helical Spring Washers are used in every automobile to retard wear and compensate for play and looseness. Particularly at such points as steering gear, spring shackles, axles, Helical Spring Washers assure vital protection.

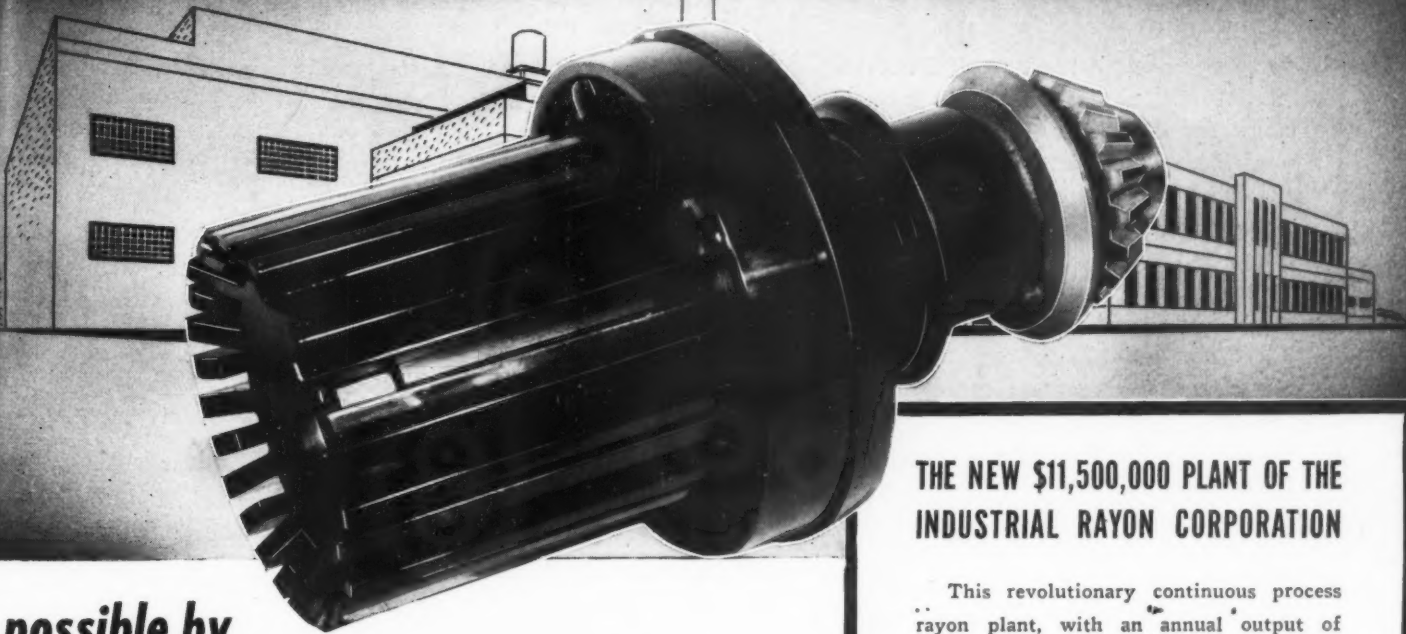
### SPRING WASHER INDUSTRY

616 WRIGLEY BLDG., CHICAGO, ILL.



MACHINE DESIGN—March, 1939

# FIRST AND ONLY CONTINUOUS VISCOSE RAYON PLANT



made possible by  
**the PLASTIC SPINNING REEL**  
Precision Molded by Richardson

In Painesville, Ohio, stands the world's first plant for the continuous production of viscose rayon yarns. There a succession of chemically resistant plastic reels of ingenious, highly-developed design, make it possible to carry rayon yarn from the spin bath where it is formed, through all the processing, cleansing, drying and twisting operations to plastic bobbins on which it is first wound up.

Mostly, time-consuming operations and multiple handling are eliminated by use of the reels, which carry each individual thread through all the processing stages for direct treatment, in-

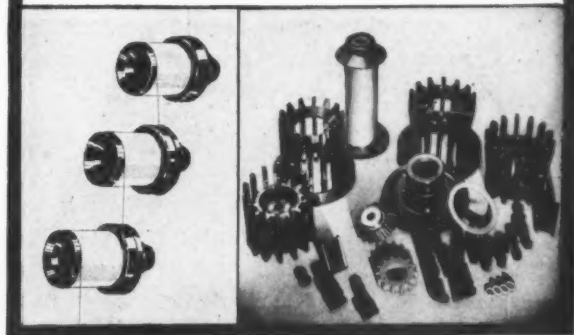
suring the ultimate in product uniformity.

Heart of the continuous process is the plastic spinning reel, developed with Richardson collaboration from complex experimental models to a simple precision molded composite reel. In addition, numerous other Richardson molded and laminated plastics are widely used—jet unions; thread guide holders and brackets; INSUROK laminated gears and seal rings; bobbins and other parts—because of their unvarying physical characteristics and resistance to all spinning and processing liquors.

## THE NEW \$11,500,000 PLANT OF THE INDUSTRIAL RAYON CORPORATION

This revolutionary continuous process rayon plant, with an annual output of 12,000,000 pounds, is the result of many years of experimental and developmental work. Perfected by Rayon Machinery Corporation, wholly owned subsidiary of Industrial Rayon Corporation, this process was made possible by the molded plastic members of the reel.

Richardson engineers, designers and plastics technicians are proud to have had an active part in writing this new epoch-making chapter in the history of the rayon industry.



Devoted exclusively to plastics, Richardson has unexcelled facilities for the volume production of intricate molded and laminated parts and finished products to exact specifications. Richardson complete service, and the same engineering and technical skill that proved its value in the Industrial Rayon Corporation development, are available to all users of plastics.

# INSUROK

the superior plastic by Richardson, is available in sheets, rods, tubes, punchings, and other forms for fabrication in your plant, or in completely finished parts ready for assembly. Richardson facilities encompass the use of Bakelite, Beetle, Durez, Indur, Plaskon, Resinox, Tenite and other forms of synthetic resin plastics. Literature and INSUROK catalogues on request.

## The RICHARDSON COMPANY

Melrose Park, (Chicago) Ill.

New Brunswick, N. J.

Indianapolis, Ind.

Lockland, (Cincinnati) Ohio

# Topics

TWO recent aeronautical events which blazed into the nation's headlines have broad significance for designers. First and most sensational was the experimental transcontinental flight of the new Lockheed substratosphere plane from March field, Calif., to Mitchel field, L. I., where it crashed on landing. This is the ship, powered by two 1000-horsepower Allison liquid-cooled V-12 engines, which was said by conservative Army Air Corps officials to have approached 400 miles per hour. Its most startling characteristic—its "in-line" cylinder arrangement—constitutes the answer to its tremendous speed. Aeronautical authorities in this country have contended for years that the physical limit of speed with the radial type aircooled engine has just about been reached. European plane builders have advanced far with "in-line" engines mounted directly in front of the wings. Perfect streamlining can be attained, so that any further speed will depend on greater engine power; and for military planes, straight-line power plants form a perfect, rigid mounting for guns. Second notable event was the nonstop transcontinental flight of an 800-pound two-seater Aeronca "Chief." No speed records were set, inasmuch as the flight took 30 hours 47 minutes. But the small plane's flight, in fuel and oil, cost only \$25.70, virtually the cheapest rate of cross-country travel. Light weight in the engine can be attributed in part to aluminum-nickel alloy for cylinder heads, cadmium-nickel alloy for connecting rod and crankshaft bearings, nickel alloy steel for crankshaft, gears, rocker arms, studs and other stressed parts.

THERE'S nothing new in the use of rubber to attain additional comfort and safety in automobiles, but it's remarkable to realize, as Chrysler Corp. points out, that rubber's utilization has increased to the point where around 300 pieces in one form or another go into cars. After years of cushioning engines, bodies, and front and rear suspensions, rubber is being used to prevent ingress of wind, snow and rain, and to prevent squeaks by grommeting parts where controls enter the car body. Nor should the development

with the most revolutionary potentialities be forgotten: Foamy latex for seats and other purposes.

GREATLY increased opacity has been attained in porcelain enamel finishes. Although applied in a coating 40 per cent thinner than that required formerly, the new enamels are said to have equal covering power. Other claimed advantages: Increased resistance to mechanical shock and deflections, greater resistance to scratching, virtual elimination of chipping, and the capacity for being sheared neatly without chipping from the edges. An authority in the finishing field points out that enamel finishes which bake rapidly at high temperatures, thus helping production speed, are becoming increasingly popular. There are limits to the use of such finishes, however. Short baking schedules at very high temperatures cannot be controlled closely enough to give uniform results. Best practice appears to be adoption of a schedule combining speed with dependability. Progress also has been made in improving durability of finishes for withstanding action of humidity and household chemicals, and in the development of transparent colored coatings which reproduce colorings of various metals and platings.

AT THE 150th meeting last week of the American Institute of Mining and Metallurgical Engineers, Dr. H. W. Gillett, Battelle Memorial institute, Columbus, O., reported new work on metals under stress, of interest particularly to designers concerned with creep of steel under heat and steam pressure. Dr. Gillett heated steel strips in special furnaces and simulated the conditions produced in boilers by attaching weights to the strips. Some of the strips expanded one six-millionth of an inch for each inch of length. A 2-foot steel bar thus would creep more than 1/10,000-inch. Since rearmament is a burning subject at present, the U. S. Navy is among the groups most interested in research of this kind. Some men in the department are in favor of equipping new battleships with boilers using steam at unusually high temperatures. Others maintain the steel now available won't stand the strain.

# *The Day of* **JACK-OF-ALL-TRADES** *is Past*

**I**n an age of specialization, the jack-of-all-trades just doesn't belong.

And in the particular branch of power transmission engineering devoted to *variable speed control* that fact becomes constantly more apparent.

With REEVES, variable speed control is a *specialty*—not just a sideline. And if our years of experience have proved anything, it is this—that the complex and technical “angles” encountered in this branch of mechanical engineering require, for successful solution, the concentrated, undivided attention and the full resources of *specialists*.

Next time somebody mentions experience in speed control, think of it this

way . . . as thousands of hours over drafting boards . . . as shirt-sleeve sweating in mills and factories diagnosing production kinks . . . as lights burning 'til midnight in front office and foreman's desk alike . . . all for the purpose of planning new uses and finding better ways to do a job.

Even correcting mistakes, if you like. Sure, we've made them. But we've been in this business long enough to be able to find the right medicine for the bugs that creep in now and then.

Result: when there's a real speed control job to be done, industry comes to REEVES, confident that we can take it in stride, knowing that our salad days are history.

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# *Variable Speed Control*

# THERE ARE 30 Hours IN A DUMORE DAY

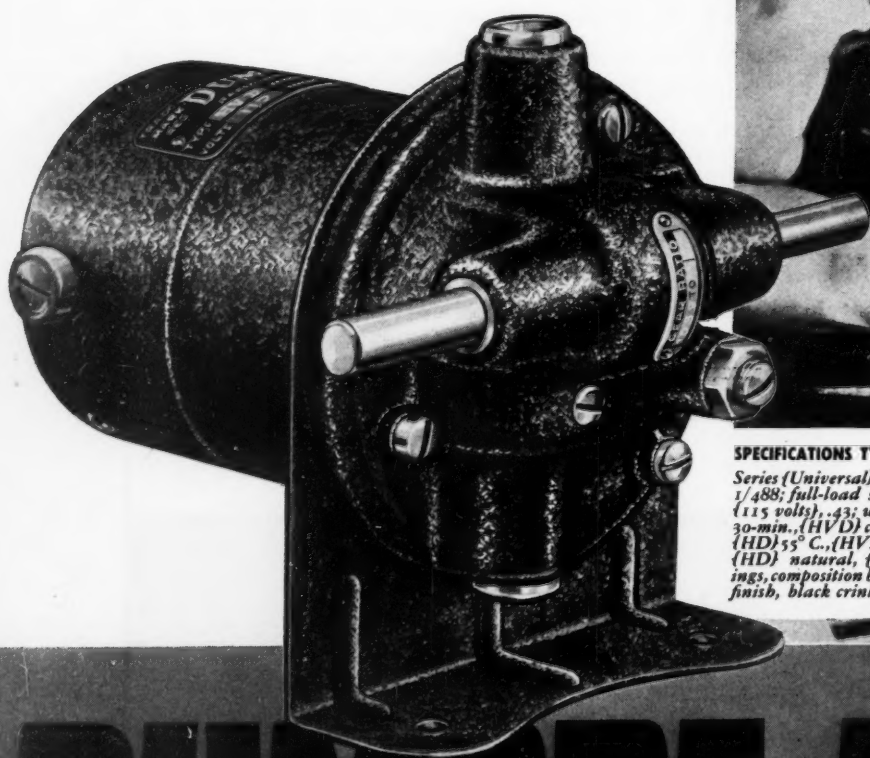
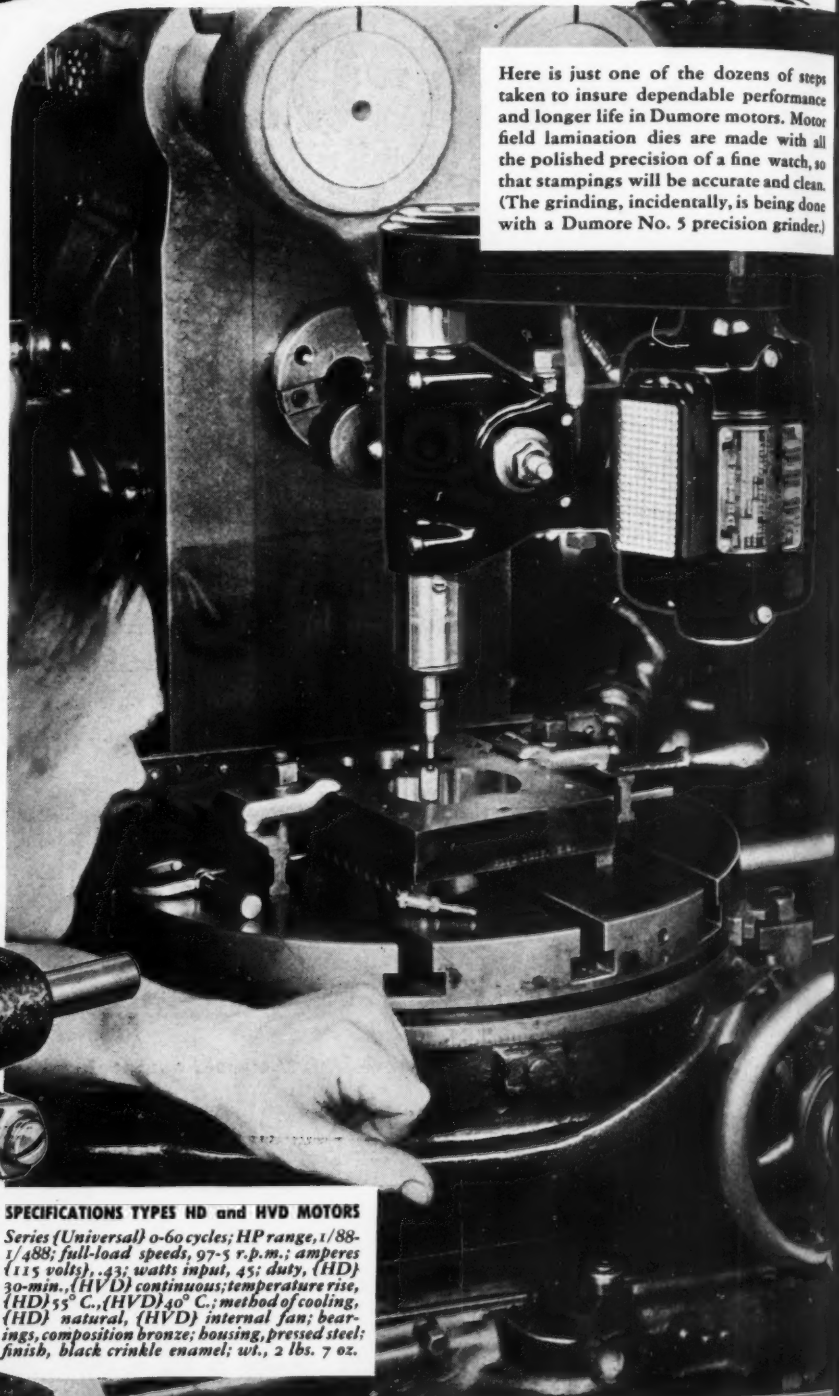


Ordinary measures of time and of work done are not enough for Dumore motors. For into every Dumore unit goes the most exacting production practices known to modern engineering, proved and perfected by 25 years of laboratory study and field experience.

You get out of a motor only what has gone into it. Here's what goes into a Dumore to give you many extra hours of power: (1) Armatures dynamically balanced to eliminate vibration; (2) Commutators ground concentric with bearings for longer life; (3) Windings expanded at high speed, then sealed; (4) Leads swaged by special process for 100% electrical contact; (5) Every motor run-in to seat brushes properly; and (6) Every motor inspected five times during manufacture. Let Dumore look at your power problem. Write for engineering service blank.

THE DUMORE COMPANY • Dept. 129-C Racine, Wis.

Here is just one of the dozens of steps taken to insure dependable performance and longer life in Dumore motors. Motor field lamination dies are made with all the polished precision of a fine watch, so that stampings will be accurate and clean. (The grinding, incidentally, is being done with a Dumore No. 5 precision grinder.)



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Series (Universal) 0-60 cycles; HP range, 1/88-1/488; full-load speeds, 97-5 r.p.m.; amperes (115 volts), .43; watts input, 45; duty, (HD) 30-min., (HVD) continuous; temperature rise, (HD) 55° C., (HVD) 40° C.; method of cooling, (HD) natural, (HVD) internal fan; bearings, composition bronze; housing, pressed steel; finish, black crinkle enamel; wt., 2 lbs. 7 oz.

# DUMORE MOTORS

FOR *Extra* POWER HOURS

zens of steps  
performance  
motors. Motor  
made with all  
fine watch, so  
rate and clean.  
is being done  
sion grinder.)



# Mile-Long Machine

## Performs Continuous Process

By R. F. Bergmann

Chief Engineer,  
Rayon Machinery Corporation

**D**EVELOPMENT and standardization of the continuous viscose rayon spinning and processing machines recently placed in operation at the Industrial Rayon Corp.'s new Painesville, O., plant presented many challenging problems which had to be solved before machines could be built and the plant equipped on a practical, commercial basis.

Without the availability of

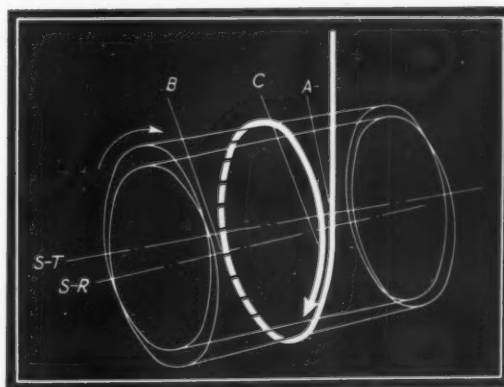
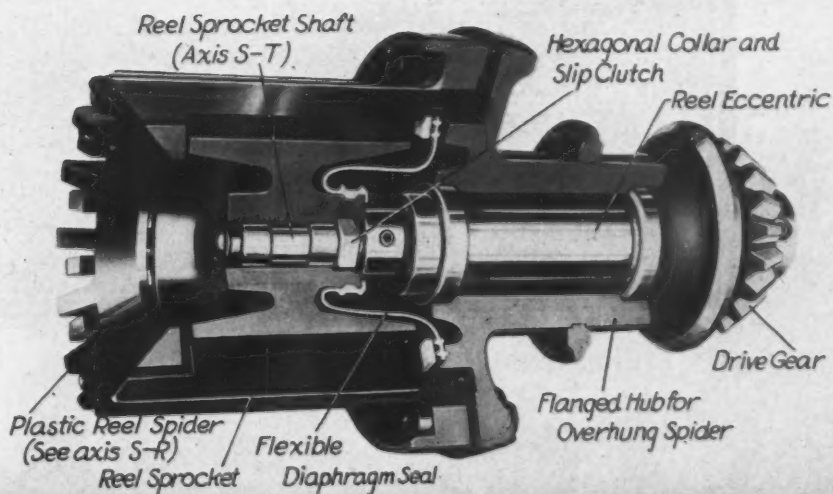


Fig. 1—Above—Second tier of the plant, on which are located the process reels. Fig. 2—Left—Principle of operation of processing, drying spin, reels. Fig. 3—Below—Assembly of parts of the processing reel, principal members being plastic

Photograph courtesy Richardson Co.



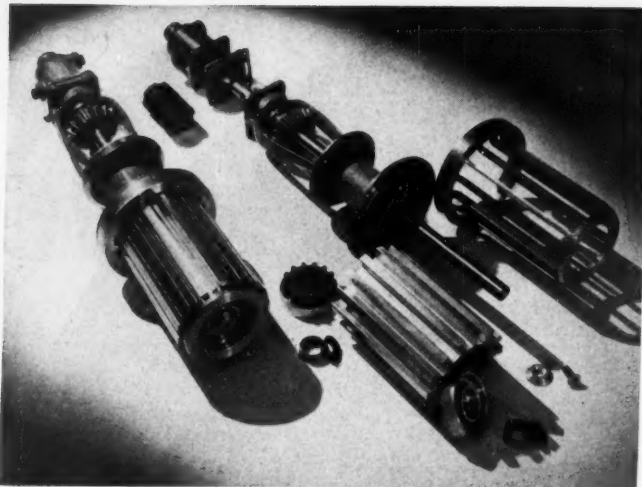


Fig. 4—Aluminum drying reel, assembled and disassembled. Principle of thread advancing on this reel is the same as on the plastic process reel, but several other aspects of its design are different

modern materials and methods the solution of these problems would not have been possible. The continuous rayon process, revolutionary in itself, depends on plastics, molded hard rubber, arc welding, extruded aluminum, permanent mold castings and forgings, sealed ball bearings and oilless bronze bushings, and unique drive mechanisms.

After preparation of liquid rayon or viscose by dissolving cellulose fiber sheets in a series of controlled chemical baths, the operations performed by the machines, of which 96, or 48 pairs are installed, include the following:

Spinning separate filaments of the yarn by forcing the viscose through minute holes of a jet or spinneret submerged in an acid bath in lead-lined, glass-enclosed spin tanks at the top of each machine.

Processing treatments, comprising washing, desulphuring, bleaching, lubricating, drying and twisting on to bobbins. Yarn is given these treatments while rotating on reels arranged in tiers, as shown in Fig. 1.

The key to the process is the continuous treatment of the yarn until it reaches its final finished form. In turn, this successive treatment is made possible by the

design of the unusual thread-advancing reel illustrated in Fig. 3.

Fig. 2 shows schematically the principle of the reel's operation. Assembly of parts of the reel is revealed in cutaway in Fig. 3. Disassembled parts are laid out in Fig. 4. Finally, the drawing of a reel in Fig. 5 shows the design in detail.

It will be seen that two kinds of reels, each employing the same principle of thread-advancing, are used. The reel in Fig. 3 is the processing reel, the principal members of which are molded of plastic. The drying reel in Fig. 4 and 5 has similar parts but made of aluminum extrusions and permanent mold castings.

To obtain the thread advancing action of the reels (described later) two slat pulleys, (a reel sprocket and an overhung reel spider) set one within the other, revolve together as an overhung assembly. These when in motion, assume the appearance of a single cylinder. They do not, however, revolve about the same center.

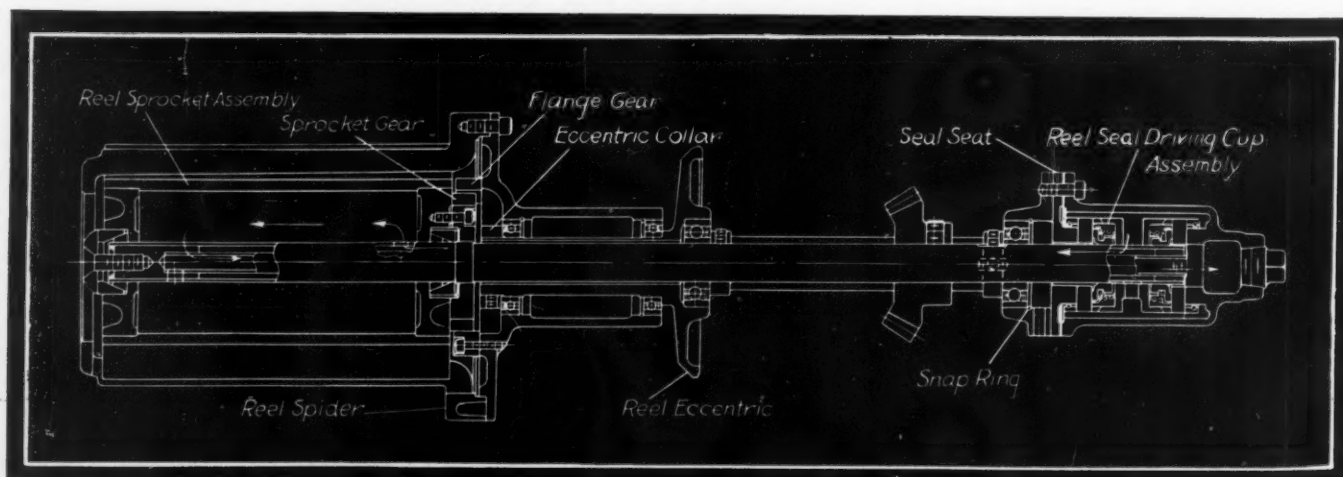
### Rotation Comes Through Sprocket

Actual rotation comes through the reel "sprocket," indicated by axis S-T in Figs. 2 and 3, driven by the cut plastic bevel gear at the right of Fig. 3. The drive shaft may be seen in the cutaway picture, as well as a hexagonal metal insert in the sprocket, which embodies an overload slip clutch. The sprocket is bronze bushed and capped on its front end. A flexible diaphragm protects all reel bearings from process solutions.

The overhung reel spider's axis is indicated by axis S-R in Fig. 2. This not only is off center but is skewed in order to impart a spiral winding to the yarn. In Fig. 3 may be seen the flanged hub for the spider, mounted on sealed ball bearings and set eccentrically. The spider rotates on this flanged eccentric, and is driven by the contact of its bars with the bars of the sprocket, with which it is nested in the assembled reel.

As indicated previously, the purpose of this ingeni-

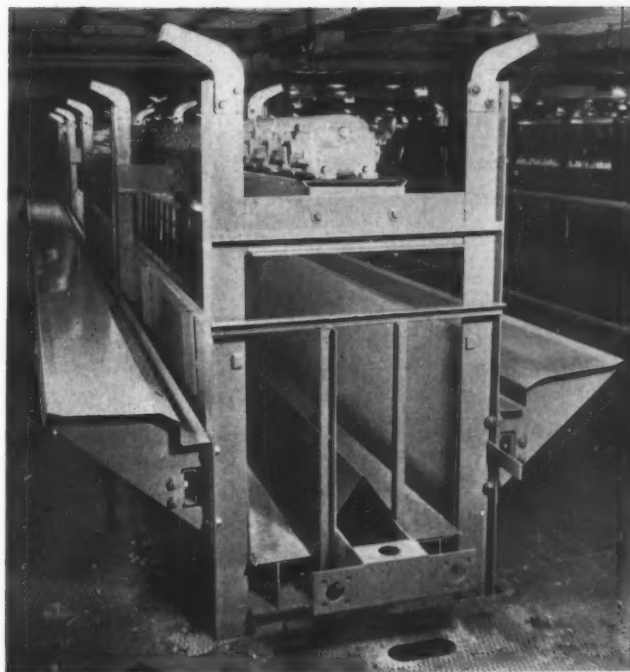
Fig. 5—Cross-sectional diagram of the dryer reel, made of aluminum because of that metal's chemical characteristics, conductivity and ability to withstand drying temperatures. Arrows indicate internal path of water



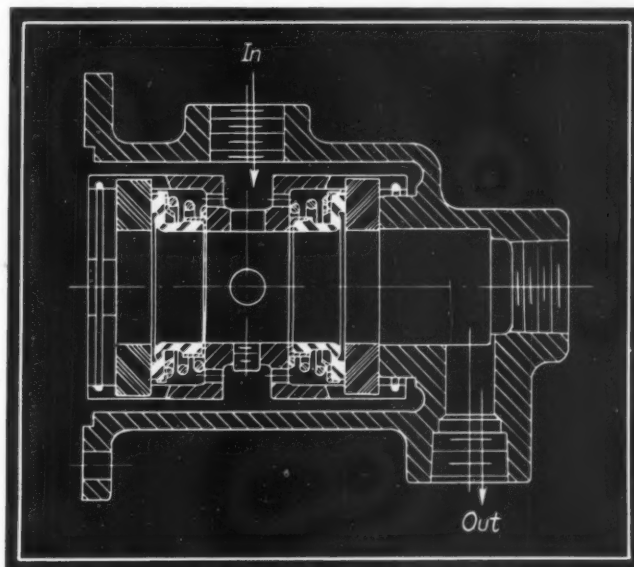
ous eccentric-skewed design is to enable the yarn to start revolving at the inboard end of the reel and move continuously and evenly to the outer edge (left in the illustration).

Yarn led on to the reel at point *A*, *Fig. 2*, travels around the bars of the lower pulley (axis *S-R*—the spider) for approximately one-half turn to point *B*. There it transfers to the bars of the upper pulley (axis *S-T*—the sprocket) and travels for another half turn to point *C*. By this time it has gone one complete turn around the reel, and because of the eccentric-skew of the spider the yarn has advanced a given distance toward the end (left) of the reel. The degree of skew controls the spacing or number of turns per inch of yarn on reel. At point *C* the yarn again transfers to the bars of the lower pulley (the spider) and successively goes through this rotation until it reaches the end of the reel and is passed to another reel below.

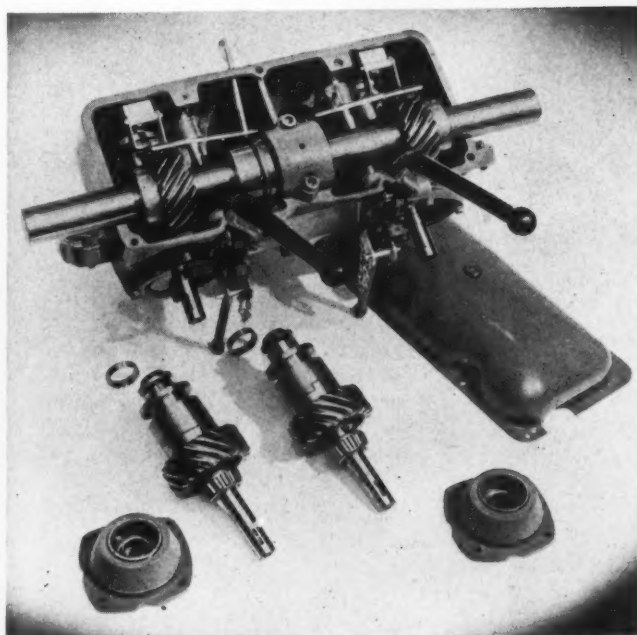
Mechanical design of these reels was a highly im-



**Fig. 6 — Below — Process reel gear box with top removed. The two right-angle take-off shafts are coupled to inclined bevel gear shafts behind the process panels in *Fig. 10*. This box may be clutched off the drive shaft and lifted out without shutting down any positions except the two served by its own output shafts**



**Fig. 7 — Left — Seal assembly for dryer reel, showing where water enters and leaves housing. *Fig. 8*—Above—Top tier of spinning machine before installation of sheet lead covering trough and ventilated hood. Here rayon is extruded into acid bath and wound on spin reels**



portant factor in the success of the machine as a whole, but choice of material for reels was also vital. The yarn during processing is subjected to warm dilute sulphuric acid, desulphurizing and bleaching solutions, hot wash waters and emulsions for lubricating. Since these liquids are poured on the yarn in motion, the reels had to be chemically resistant for indefinite periods without dimensional changes.

Plastics, accurately molded and machined, were finally chosen for the process reel members. All plastic reel parts are interchangeable in dimensions, and may be assembled with eccentrics which will provide yarn spacing used on any of the nine stages.

The drying reel is shown in *Fig. 4*, assembled and disassembled, and in *Fig. 5*. This reel operates on the same principle as the plastic process reel, but is changed in several other aspects of its design. By the time the yarn reaches this reel it has gone through its treatment and must be dried before being twisted on

to bobbins. Aluminum was chosen for the reel's material because of its chemical characteristics, conductivity and ability to withstand drying temperatures. The reel sprockets are hollow aluminum extrusions. Blanks from these extrusions, counterbored and plugged on each end with finished forged aluminum heads, provide a practical, dependable water-jacketed medium for drying the yarn.

For drying purposes hot water is passed through the reel and out again, the arrows in *Fig. 5* showing the path of the water. In *Fig. 7*, showing the seal assembly for the dryer reel, a portion of the water's course also may be seen. The water enters the housing, travels to the other end of the reel, and returns through the center tube to the housing. Actually, in *Fig. 5* the inlet is on the far side.

#### Welded Construction Found Best

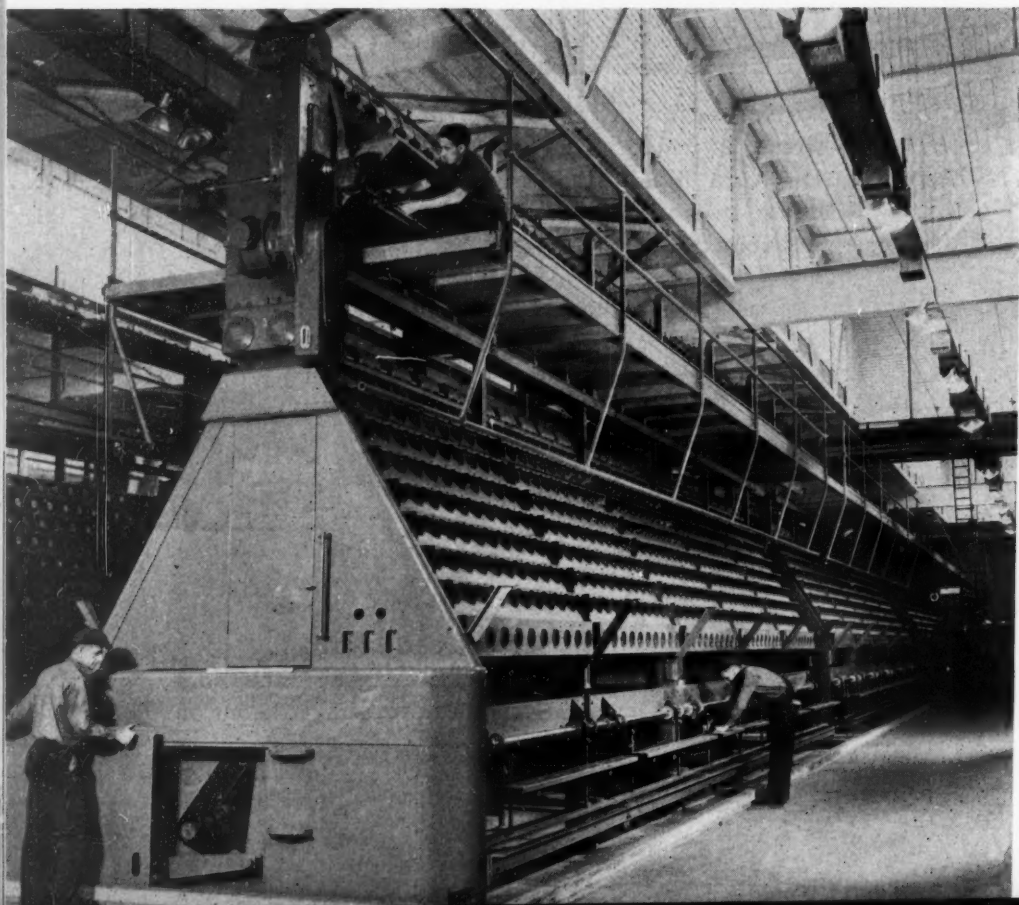
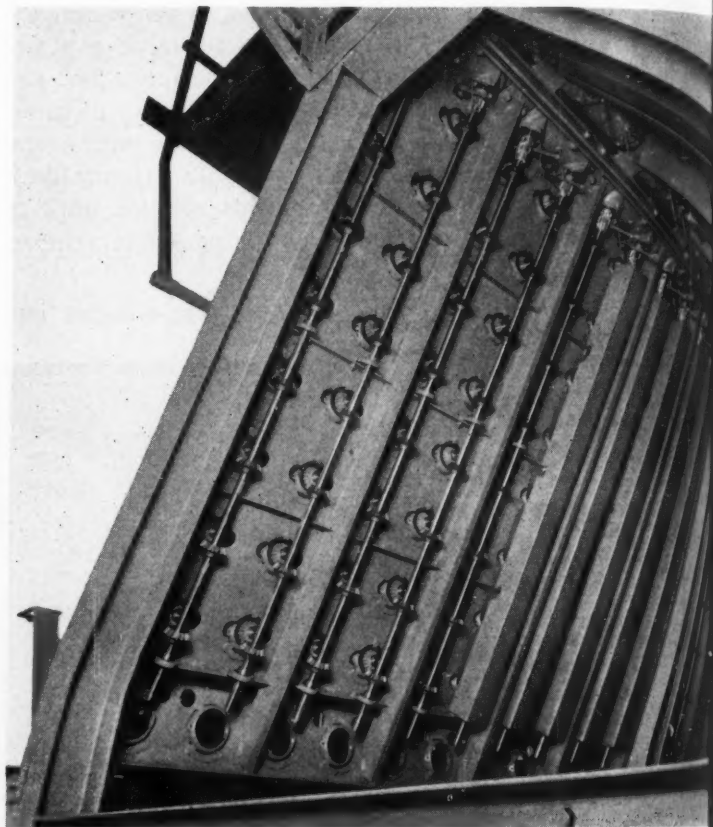
Before discussing the transmissions which drive the process and spinning reels, mention should be made of the general appearance and construction of the machine (actually, of course, 96 separate but co-ordinated units). Preliminary studies revealed that fabricated and welded steel construction offered the greatest possibilities for this machine. The most logical arrangement for combining the rayon spinning and processing stages was to tier them, thus gaining compactness, saving floor space and providing ease of threading when starting or resuming operations on any position.

An A-shaped structure, symmetrical about a vertical center line and with three operating levels was developed, the second level being shown in *Fig. 1*. Despite considerable skepticism, jig welding was employed in

joining the assembly. Easily obtainable, rolled structural steel sections were used wherever possible.

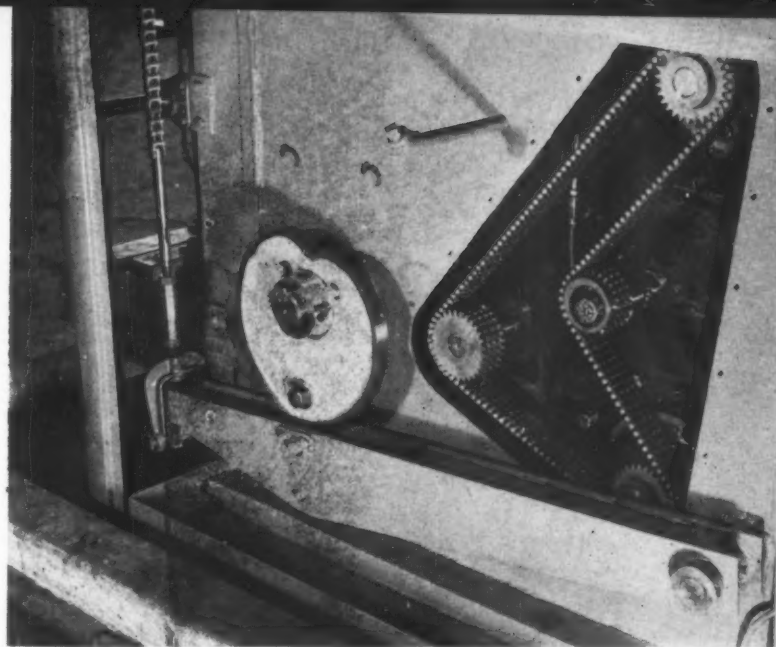
It was desired to avoid any machining of surfaces after the assembly was welded and removed from the jigs. This was eliminated by the extensive use of flanged bearing housings and adjustably mounted transmissions, aligned and doweled on erection.

*Fig. 8* shows the top of spinning machine before installation of the sheet lead covering trough and venti-



**Fig. 9—Left—**View of lower tier showing twister tables, grouped in series of five, which twist yarn on bobbins. Workman at left is fitting panel over cam mechanism and duplex silent chain drive. Tables are counterweighted and suspended by pulleys and shafts on each side of the machine. See *Fig. 11* for more complete picture of cam mechanism. **Fig. 10—Above—**Behind the process panels where gears on the inclined shafts drive the nonmetallic gears on the process reels

Fig. 11—Right—Cam mechanism for twister tables is totally enclosed and chain tensions are maintained by spring-backed automatic idlers. Force feed lubrication from an oil sump in the bottom of each casing is provided for all chain drives. Fig. 12—Below—Drive unit for the spin and process reels. At top is a worm drive, output shaft of which is extended through the spin reel transmissions shown in Fig. 8. At bottom is a worm gear shaft with two output shafts, each coupled to a longitudinal drive shaft extending through the process reel gear boxes on the second tier



lated hood. Here the rayon is extruded into the acid bath and first wound on spin reels driven by the gear box units shown. Catwalks for operators are cantilevered from the frame members.

The drive unit for the spin and process reels is shown in Fig. 12. At the top is a worm drive, the output shaft of which is extended through all the spin reel transmissions shown in Fig. 8. At the bottom is a worm gear drive with two output shafts, each coupled to a longitudinal drive shaft which extends through the process reel gear boxes on top of the stepped, welded process panels on the second tier.

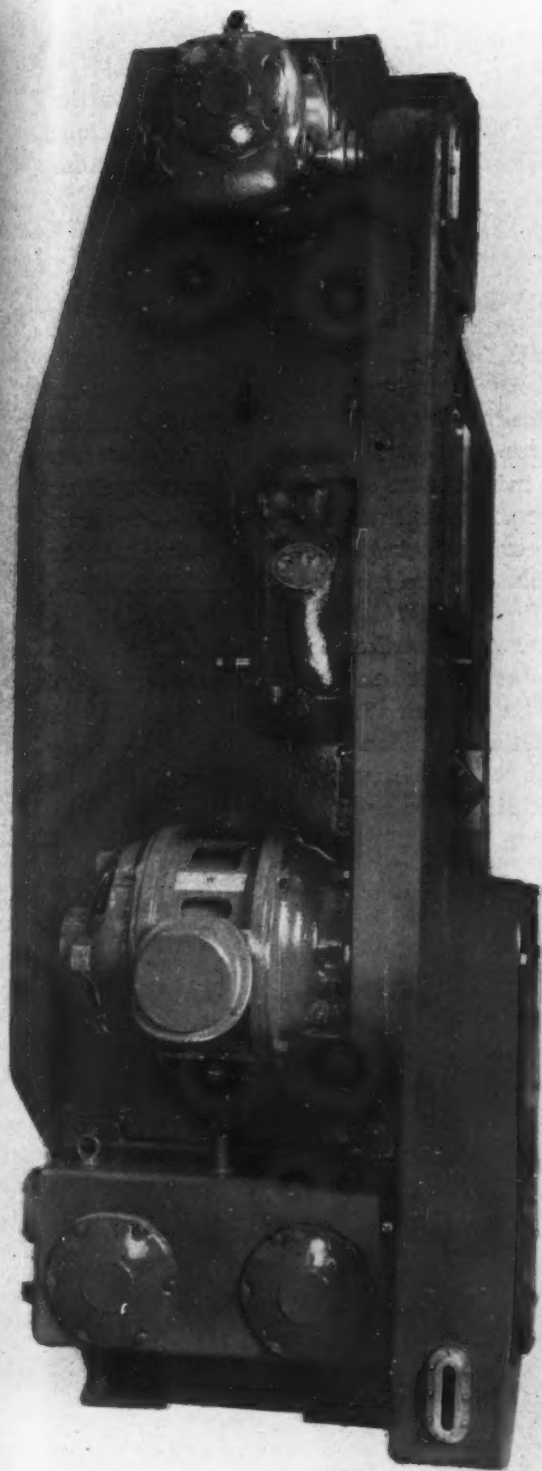
#### Box Has Two Take-Off Shafts

Fig. 6 shows one of these transmission units. Each box has two right angle take-off shafts, which are coupled to inclined bevel gear shafts behind the process panels as can be seen in Fig. 10. Gears on the inclined shafts drive the self-lubricating plastic gears on the process reels. Each of the spiral driven gears in the transmission engages with a splined spiral clutch, which may be shifted to clutch out the line of reels driven by the inclined bevel gear shaft to which the output shaft of the gear box is coupled.

An interesting feature of the process transmission is the fact that it may be completely removed from the machine for servicing and re-installed without shutting down any positions except the two served by its own output shafts. After removing the cover, clutch levers and through shaft bearing cap, the entire box may be lifted out over this shaft and removed. Similar provision has been made for servicing individual elements on all other stages of the machine, so that it is never necessary to cut out of production more than one or two spinning and processing positions, out of the total of 100 provided.

Final stage of the machine's operation, the twisting of yarn on bobbins, involves the totally enclosed duplex silent chain drive and the cam mechanism in Fig. 11.

(Concluded on Page 41)



# Scanning Ideas

## THE FIELD FOR

### Unique Diesel Has Variable Stroke

**T**WO horizontal and opposed pistons transform power directly into compressed air energy in a two-cycle diesel engine designed by the French firm, Breguet. According to Alfred Wasbauer, consulting engineer, there is no mechanical intervention other than a rigid connection between the diesel pistons and compressor pistons. Travel of the opposed pistons is synchronized by a pair of connecting rods joined to a double-end rocker arm as shown in *Fig. 1*.

A unique feature of the compressor, besides the absence of crankshaft and rotating members, is the variable stroke of the pistons determined by the amount of fuel injected into the diesel cylinder. When the fuel is reduced to the point where there is no compressed air discharge, the compressor idles. Naturally, it is always the compressed air remaining in the air cylinders which sends the pistons on their return course. This novel mode of operation results in high efficiency, particularly at high altitudes.

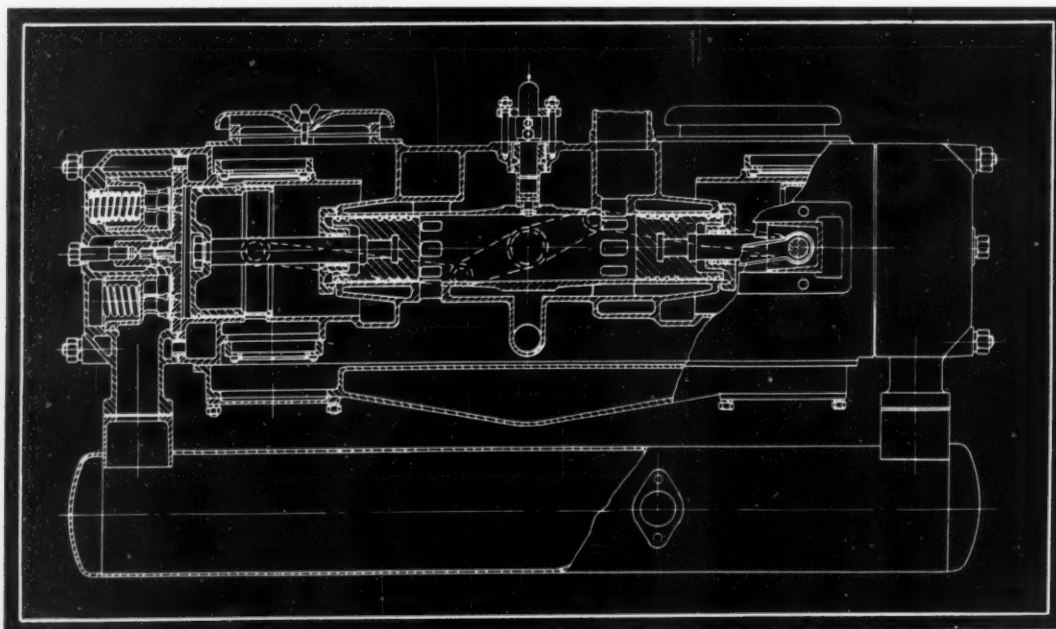
Actuated by the expenditure of air, an automatic governor acts directly on the fuel pump to regulate

the course distance of the pistons according to the needs of the moment. Perfect balance of the pistons and the absence of transmittable rotative stresses makes a light construction possible.

### Self-Contained Telephone System

**O**BTAINING its power solely from the speaker's voice, a newly designed telephone generates its electrical voice-transmitting current from the impact of sound waves on a special diaphragm. Its operation is therefore independent of external power, making the unit especially useful where self-contained systems are desirable or where independent operation may be required. This unit, designed by Western Electric Co., is shown in *Fig. 2*.

When sound waves strike the diaphragm, an armature vibrates and varies the air gaps between it and pole pieces of a magnet. This changes the reluctance of the magnetic circuit and induces voice frequency currents in a coil which surrounds the armature but does not touch it. Conversely, when voice currents are



**Fig. 1—Variable stroke diesel using balanced, opposed pistons is integral with air compressor**

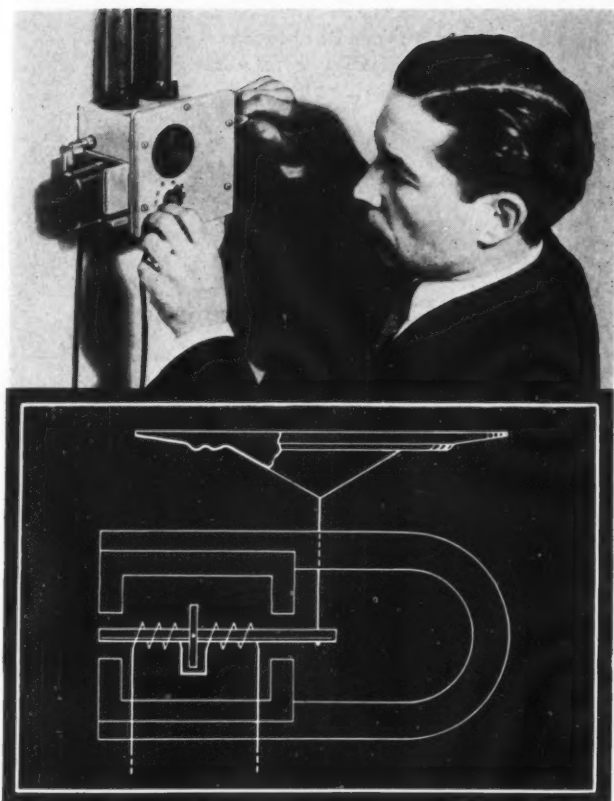


Fig. 2—Voice produces power for telephone. Blue-print shows how diaphragm generates current

imposed on the coil, the armature and diaphragm vibrate and reproduce speech. In this way the single instrument serves alternately as transmitter and receiver.

Signaling current is generated at any station by a hand-operated generator to create an audio frequency current by rapidly varying the reluctance of the magnetic circuit. Two disks with teeth of magnetic material are so placed with respect to the armature and magnet that their rotation generates alternating current of about 1,000 cycles per second. Removing the receiver from the hook transfers the telephone from a signaling to a talking circuit.

Duralumin is used for the cone-shaped diaphragm. To obtain an efficient magnetic circuit with small, lightweight parts, a magnet of remalloy is utilized. Pole pieces, armature and teeth of the rotors are permalloy, the teeth themselves being separated by non-magnetic material to reduce leakage.

### Tungsten Grains Dampen Bounce

WHERE it is desirable to dampen vibrations without a mechanical lock-in device for delicate mechanisms such as contacts used in sensitive relays, an important principle of energy absorption has been applied. Without damping features, contact arms would bounce repeatedly in absorbing the energy of impact. To remedy this critical fault, non-bounce con-

tacts have been developed that contain a hollow capsule partially filled with fine grains of tungsten.

In operation, such contacts make positive connection immediately on closing. All the energy is dissipated within the capsule by interfriction between the heavy grains of tungsten. High speed oscillographs have shown no indication of separation following initial closure during tests.

### Concave Members Actuate Switch

THE principle of thermal expansion of an enclosing shell to separate electrical contacts on thermally inert members has been applied by Fenwal, Inc. in the form of a unique thermo-responsive electric switch. This unusual design is shown in Fig. 3.

The switch has a sensitivity of  $\pm 1/10$  degree Fahr. with no thermal lag. Reference to the illustration shows the thermo-responsive element is an outer brass shell enveloping the entire unit. Silver contacts are affixed to the electrical leads and mounted upon bi-concave compression members of thermally inert metal. These members press the contacts together firmly while they are closed.

A calibrated adjusting screw in the head puts an initial stress on the members so that, when the shell is extended by heat, the contacts are pulled apart at a predetermined setting. An inverse type has also been designed in which the members are convex so that heating forces the contacts together to complete the electrical circuit.

Movement of the contacts is slow break, yet their separation is approximately 20 times the expansion of the shell. Therefore make-and-break are definite with small changes of temperature. Sputtering due to vibration of contacts has been eliminated because the force necessary to overcome contact pressure is great enough to prevent vibration.

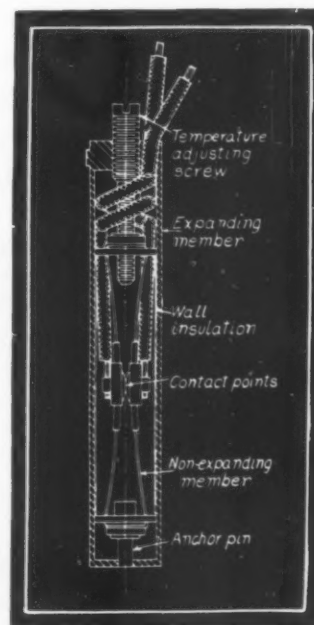


Fig. 3—Thermal switch is enclosed within active element. High sensitivity is assured by novel construction

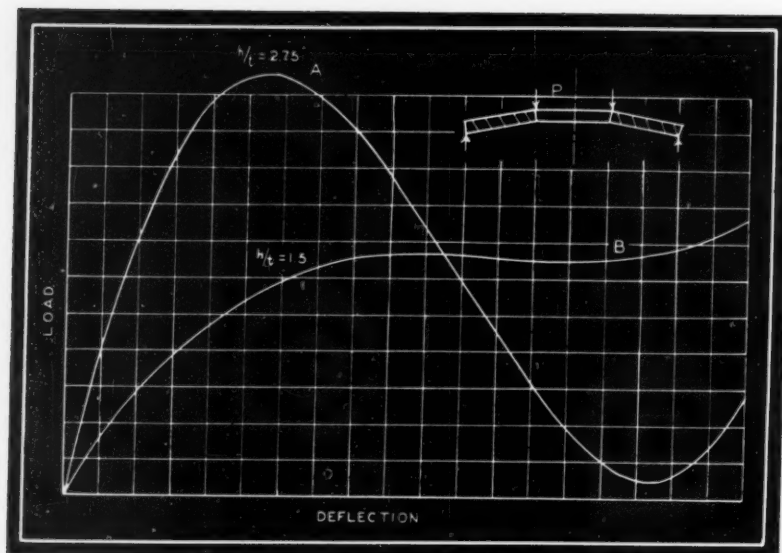


Fig. 1—Curves in chart illustrate two types of characteristics obtainable with disk springs

# Design and Displacement

By A. M. Wahl

**M**ANY spring applications require nonlinear load deflection characteristics of various forms. Such characteristics are useful in design and may be obtained with initially coned disk springs, commonly called Belleville springs. Often springs having approximately zero rate over a limited range and those having buckling characteristics are desired and may be obtained by varying the ratio of initial cone height to disk thickness.

Design of these springs is discussed in this article together with charts and formulas for facilitating practical application of stress and deflection equations as developed at Westinghouse Research Laboratories. For given proportions, deflections for varying loads may be determined from the curves. Also discussed are designs of initially flat, radially tapered disk springs. Numerical examples illustrate practical applications of equations and curves.

## Design of Belleville Springs

In certain cases a load characteristic of the shape shown in curve *B* of Fig. 1, which has a load deflection rate of approximately zero over a considerable range of deflection, may be desirable. Other applications may require the type of characteristic indicated in curve *A*. Both of these types, as well as a wide variety of intermediate shapes, may be obtained by using initially coned disk springs of uniform thickness. Changes in the shape of the curve are effected by varying the ratio of cone height *h* to disk thickness *t* as shown in Fig. 2. Thus, in Fig. 1, curve *A* is obtained for a ratio  $h/t = 2.75$  and curve *B* for a ratio  $h/t = 1.5$ .

Where space is limited in the direction of load application, use may be made of Belleville springs or radially tapered disk springs. The latter springs have a thick-

ness proportional to the radius, as shown in Fig. 3, and may be found advantageous. An application of this type of spring in the design of motor commutators is illustrated in Fig. 4. The main advantage of a radially tapered disk spring is that the stress is practically constant along the radius, whereas in the Belleville type of spring the radial stress distribution is nonuniform. Therefore more energy may be stored in a given volume of material for the same maximum stress in a radially tapered disk.

An exact mathematical solution of the stresses and deflections, Fig. 1, in a Belleville spring under given loads is extremely complicated. It is, however, possible to obtain an approximate solution to this problem by

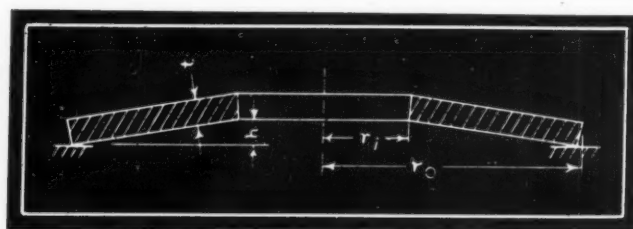
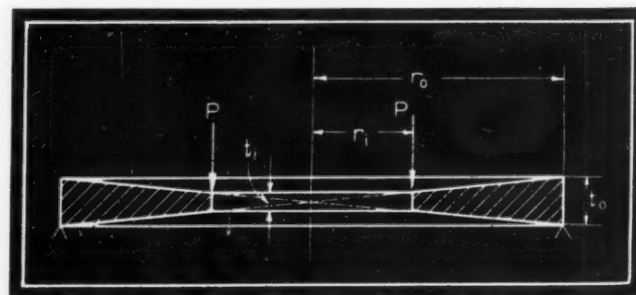
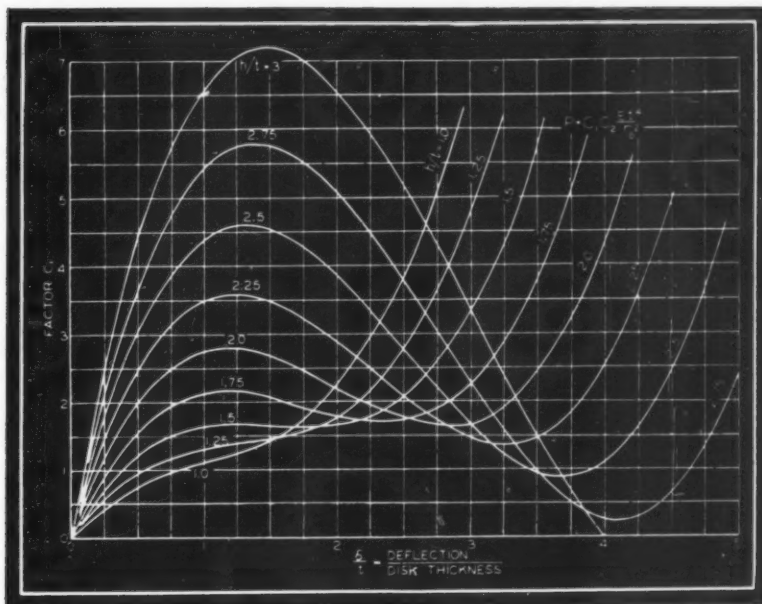


Fig. 2—Above—Belleville spring. Fig. 3—Below—Radially tapered disk spring. Symbols used in formulas are indicated



# and selection of Disk Springs

Fig. 5—Curves for determining deflection factor  $C_1$  for Belleville springs



assuming that the dish angle is small and that under deflection radial cross sections of the spring rotate without distortion. In this manner, solutions for calculating deflections and stresses in Belleville springs have been obtained by Almen and Laszlo<sup>1</sup> who give the following formulas<sup>2</sup>:

$$P = \frac{E \delta C_2}{(1-\mu^2) r_o^2} \left[ (h-\delta) \left( h - \frac{\delta}{2} \right) t + t^3 \right] \dots (1)$$

where

$$C_2 = \left( \frac{\alpha+1}{\alpha-1} - \frac{2}{\log_e \alpha} \right) \pi \left( \frac{\alpha}{\alpha-1} \right)^2 \dots (2)$$

$$S_1 = - \frac{E \delta C_3}{(1-\mu^2) r_o^2} \left[ C_1' \left( h - \frac{\delta}{2} \right) + C_2' t \right] \dots (3)$$

$$S_2 = - \frac{E \delta C_3}{(1-\mu^2) r_o^2} \left[ C_1' \left( h - \frac{\delta}{2} \right) - C_2' t \right] \dots (4)$$

where

1. "The Uniform Section Disc Spring", Trans. A.S.M.E., May, 1936, p. 305.
2. The notation has been changed somewhat from that used by these writers.

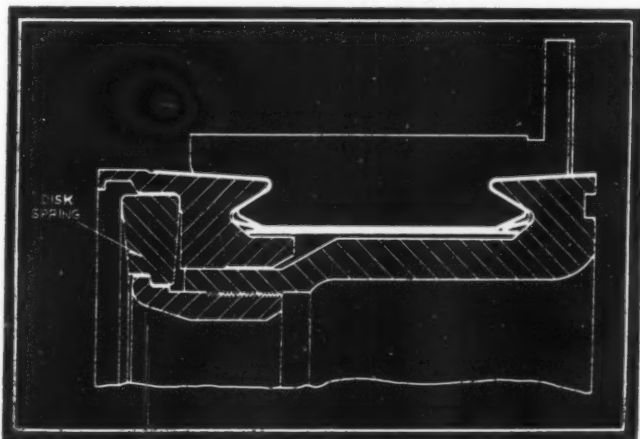


Fig. 4—Application of disk spring in motor commutator showing compactness of design

$$C_1' = \left( \frac{\alpha-1}{\log_e \alpha} - 1 \right) \frac{6}{\pi \log_e \alpha} \dots (5)$$

$$C_2' = \frac{3(\alpha-1)}{\pi \log_e \alpha} \dots (6)$$

A negative value for  $S_1$  or  $S_2$  denotes compression, a positive value tension.

The symbols have the following meanings:

$P$  = axial load on spring, assumed uniformly distributed along inner edge, Fig. 1

$\delta$  = deflection due to load  $P$

$h$  = cone height with spring in unloaded condition, Fig. 2

$E$  = modulus of elasticity of material

$r_o$  = outside radius of spring, Fig. 2

$r_i$  = inside radius of spring

$t$  = disk thickness

$\alpha = r_o/r_i$

$\mu$  = Poisson's ratio (taken as .3 for steel)

$S_1$  = stress at upper inner edge of spring

$S_2$  = stress at lower inner edge of spring

Equation (1) may be written

$$P = C_1 C_2 \frac{E t^4}{r_o^2} \dots (7)$$

where

$$C_1 = \frac{\delta}{(1-\mu^2) t} \left[ \left( \frac{h}{t} - \frac{\delta}{t} \right) \left( \frac{h}{t} - \frac{\delta}{2t} \right) + 1 \right] \dots (8)$$

To facilitate practical computations, in Figs. 5 and 6 the value  $C_1$  has been plotted as a function of  $\delta/t$  for various values of  $h/t$ , to cover the chief practical range of interest. To obtain greater accuracy, Fig. 6 may be used for the smaller values of  $C_1$ . Values of  $C_2$  are plotted as functions of  $\alpha = r_o/r_i$  in Fig. 7.

It should be noted that the factor  $C_1$  is directly proportional to the load. Each curve of Figs. 5 and 6 therefore represents the load deflection diagram for the given value of  $h/t$ . Since these curves are independent of the ratio  $r_o/r_i$  between outer radius and

inner radius, it follows that the shape of the load-deflection characteristic can be changed materially only by altering the ratio  $h/t$  between initial cone height and disk thickness. At  $h/t = \sqrt{2}$  (shown dotted in Fig. 6) the curve has a horizontal tangent and for a considerable range the rate is low. For  $h/t = 1.5$  there is an even greater range of low spring rate but in this case the load drops slightly after reaching a maximum. When  $h/t$  reaches a value of about 2.8 the load drops below zero at the larger deflections, so that buckling of the spring occurs. As may be seen from Fig. 5, a wide variety of types of curves may be obtained by changing  $h/t$ . Interpolation may be used

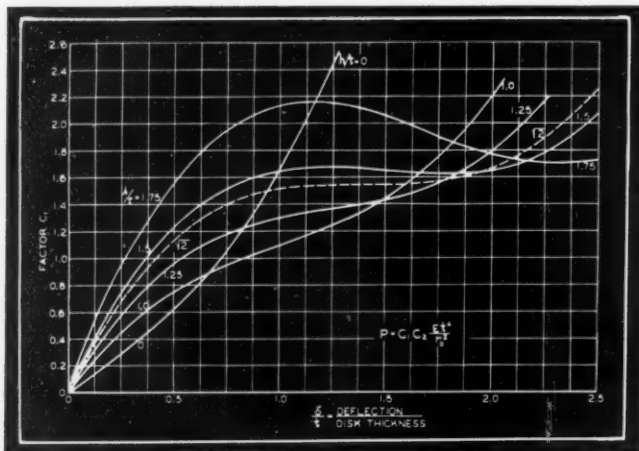


Fig. 6—Curves for determining deflection factor  $C_1$  for the lower ratios of deflection to disk thickness

with sufficient accuracy for most practical purposes.

For calculating stress, Equation (3) or (4) may be written

$$S = K_1 \frac{E t^2}{r_o^2} \dots \dots \dots (9)$$

where

$$K_1 = - \frac{C_2 \delta}{(1 - \mu^2) t} \left[ C_1' \left( \frac{h}{t} - \frac{\delta}{2t} \right) \pm C_2' \right] \dots \dots (10)$$

If the positive sign is used before the constant  $C_2'$  the stress in the upper inner edge is obtained, while using the negative sign yields the stress at the lower inner edge. It is thus seen that the stress is a function of  $\alpha = r_o/r_i$ ,  $\delta/t$ , and  $h/t$ .

For facilitating practical computations, values of  $K_1$  have been plotted as functions of the ratio  $\delta/t$  for various values of  $h/t$  in Figs. 8 and 9. For ratios  $r_o/r_i$  equal to 1.5, the curves of Fig. 8 apply, a positive value of  $K_1$  representing tension stress, a negative representing compression stress. It was found that within the range shown by the curves for values of  $h/t$  between 1 and 3 (where  $\delta < 2h$ ) the maximum stress will be compression at the upper inner edge. For deflections  $\delta$  equal to  $2h$ , the tension in the inner edge equals the compression in the upper, and for  $\delta > 2h$ ,

the tension in the lower edge becomes the limiting factor.

This is shown by the upper curve for  $h/t = 1$ , i.e. when  $\delta/t = 2$  or  $h = 2t$  then the compression and tension stresses at the two edges become equal, and for  $\delta/t > 2$  the upper curve yields higher values. For most practical cases where  $h/t$  is between 1 and 3 the maximum stresses will be obtained by using the lower group of curves in Figs. 8 and 9. Interpolation may be used for intermediate values of  $h/t$ . In doubtful cases where  $\delta > 2h$ , the stress should be checked by using Equations 3 and 4.

In Fig. 9, a similar series of curves is given for computing the factor  $K_1$  for a ratio  $r_o/r_i = 2$ . These curves also will hold within a few per cent for ratios  $r_o/r_i$  between 2 and 2.5. For ratios between 1.5 and 2 linear interpolation may be used between Figs. 8 and 9 with sufficient accuracy. Thus at a ratio  $\alpha = r_o/r_i = 1.75$  the average value obtained from Figs. 8 and 9 should be used.

### Application of Formulas

A considerable number of deflection tests has been carried out by Almen and Laszlo on Belleville springs of various proportions. These tests indicate that Equation 1 for calculating deflection, on which the curves of Figs. 5 and 6 are based, is sufficiently accurate for most practical purposes. However, this equation is not exact and in practice, therefore, deviations as high as 10 to 15 per cent from test values may be expected in some cases. For highest accuracy actual deflection tests should be carried out. If sufficient load cannot be obtained from one disk a stack of disks in parallel may be used as indicated on the sketch of Fig. 10. This figure also shows the load-deflection characteristic of such a stack of disks. The initial large deflection was due to flattening out of irregularities in the stack of springs. Although the disks were slight-

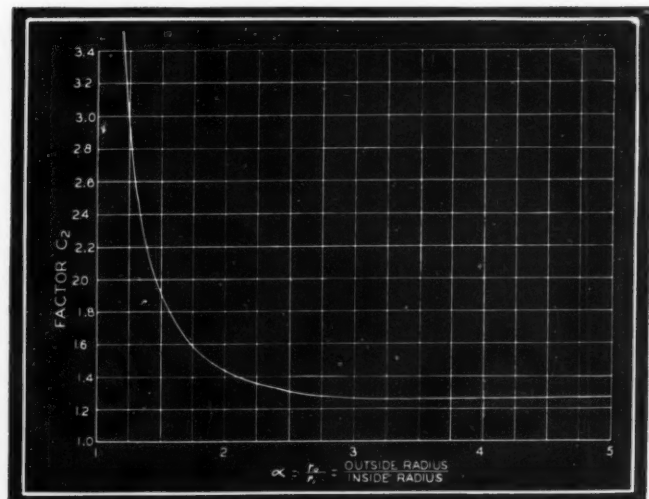


Fig. 7—Values of factor  $C_2$  from ratio of outside radius to inside radius

ly oily, considerable friction between them was present as indicated by the hysteresis loop. By using a group of springs in this manner, the load is increased approximately in proportion to the number of disks.

### Applying Belleville Springs

If the application is such that the springs are under a static load, permissible stresses of 200 to 220,000 pounds per square inch as calculated by Equations (3) and (4) are suggested by Almen and Laszlo for carbon spring steel. Although this stress seems extremely high, these writers state that experience shows the springs will function satisfactorily under static loads even at these stresses. The explanation may be that: (1) Yielding takes place so that the actual stress is less than the computed values; (2) for the usual application the maximum stress is compressive; and (3) the stress formula may be somewhat in error.

For applications under repeated loading so that fatigue enters, little data are at hand for determining maximum allowable stresses. It is probable, however, that under such conditions the permissible maximum stress would be reduced considerably, the amount of reduction depending on the stress range.

**Example 1.** To illustrate the use of the curves in Figs. 5 to 9, assume that a spring is to be designed for the following conditions: The spring is for use in a gasket application where the load is to be held ap-

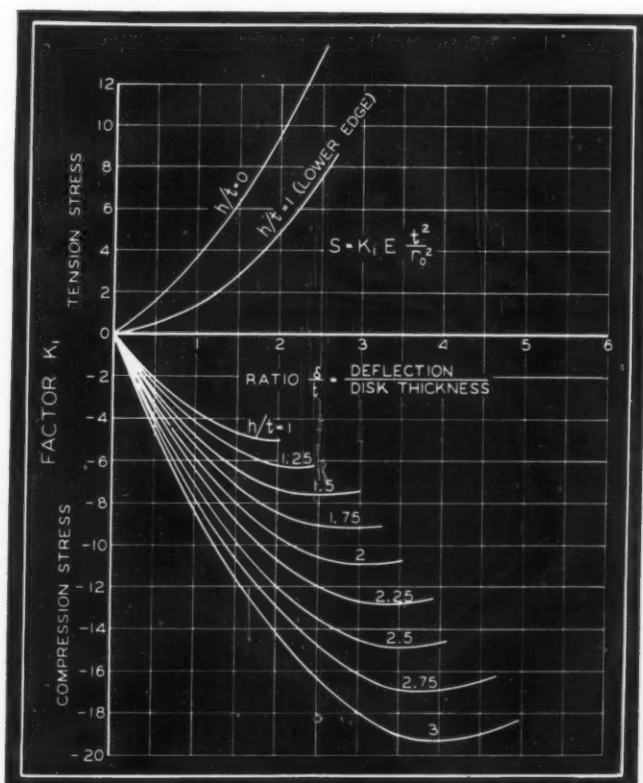


Fig. 8—Stress factor  $K_1$  for values of outside radius to inside radius = 1.5

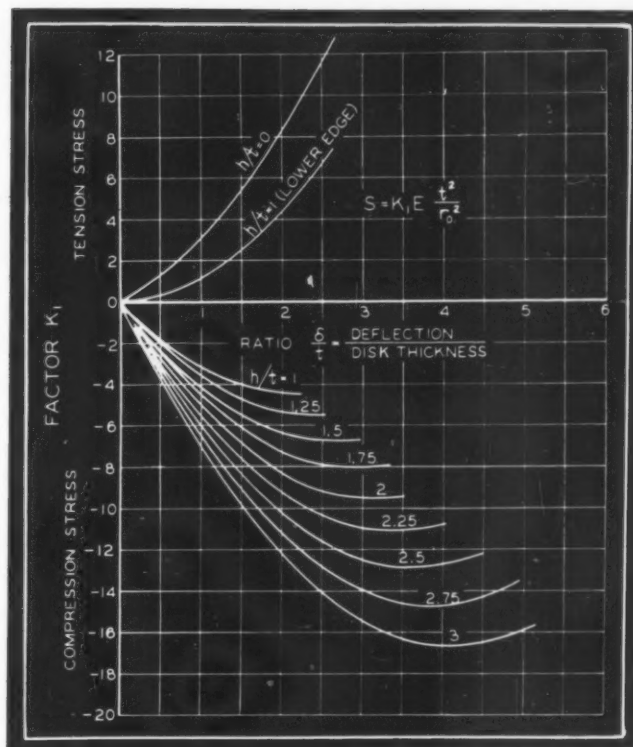


Fig. 9—Stress factor  $K_1$  for values of outside radius to inside radius = 2 to 2.5

proximately constant at 6000 pounds so that the type of load-deflection curve desired is that for  $h/t = 1.5$  (Fig. 1). The space available will permit using an 8½ inch outside diameter spring. Deflection of the spring may vary between ¼ and ¾ inch at the design load and the maximum stress is to be limited to 200,000 pounds per square inch. Taking  $r_o = 4\frac{1}{4}$  inches,  $r_i = 2\frac{1}{4}$  inch,  $\alpha = r_o/r_i = 2$ , from Equation (9) we have  $S = K_1 E t^2 / r_o^2$  where  $K_1 = -6.7$  from Fig. 9 for  $h/t = 1.5$ , this being the maximum value. Solving this for  $t$ , and taking  $S = -200,000$  pounds per square inch (compression), we find

$$t = r_o \sqrt{\frac{S}{K_1 E}} = 4.25 \sqrt{\frac{200,000}{6.7 \times 30 \times 10^6}} = .134 \text{ inch}$$

From Fig. 6 for  $h/t = 1.5$ ,  $C_1 = 1.68$  on the flat part of the curve and from Fig. 7, for  $\alpha = 2$ ,  $C_2 = 1.45$ . From Equation (7) the load per disk will be

$$P = C_1 C_2 \frac{E t^4}{r_o^2} = \frac{1.68 \times 1.45 \times 30 \times 10^6 \times (.134)^4}{(4.25)^2} = 1300 \text{ pounds}$$

Since we desire 6000 pounds it will be necessary to use 5 springs in parallel, which will give approximately the right load. From Fig. 6 it is seen that for  $h/t = 1.5$ ,  $C_1$  is approximately constant from  $\delta/t = .75$  to  $\delta/t = 2.1$ . Since  $t = .134$ , this means the load will be constant from  $\delta = .75 \times .134 = .1$  inch to  $\delta = .28$  inch which is about what is required. If the maximum deflection is ¼ inch the maximum value of  $\delta/t$  will be  $.25/.134$  or about 2. From Fig. 9, for  $\delta/t = 2$

the factor  $K_1$  will be about -6.4 instead of -6.7 which means that the calculated maximum stress will be slightly less than 200,000 pounds per square inch. The calculated load may be reduced from 6500 pounds to 6000 pounds by reducing the thickness about 2 per cent.

### Where Snap Action Is Desired

**Example 2.** Assume that a curve such as that shown in Fig. 5 for  $h/t = 2.5$  is desired for a snap action device, to operate in such a way that when the load reaches a certain point represented by the peak on the curve, the system becomes unstable and a large deflection occurs with resulting snap-action. Assume that a maximum load of about 520 pounds is desired, that space is available for an 8 inch diameter disk and that a stop is provided so that the spring may deflect  $\frac{1}{4}$  inch before coming against the stop. It is desired that at  $\frac{1}{4}$  inch deflection when the spring is against the stop the load will be represented by point on curve for  $h/t = 2.5$  corresponding to  $\delta/t = 3$ . Since at maximum deflection  $\delta = \frac{1}{4}$  inch this means that  $t = .25/3 = .0833$  inch and  $h = 2.5 \times .0833 = .208$  inch. Assuming  $\alpha = 2$ , from Fig. 9 we find  $K_1 = -12.5$  for  $\delta/t = 3$ ,  $h/t = 2.5$ . From Equation (9), solving for  $r_o$ .

$$r_o = \sqrt{\frac{K_1 E t^3}{S}}$$

Taking  $S = -180,000$  pounds per square inch (compression),  $t = .0833$  inch and solving,  $r_o = 3.8$  inch, say  $3\frac{3}{4}$  inch. From Fig. 7, for  $\alpha = 2$ ,  $C_2 = 1.45$  and from Fig. 5, the maximum value of  $C_1$  (corresponding to maximum load) for  $h/t = 2.5$  is 4.6. From Equation (7) the peak load is

$$P_{max.} = C_1 C_2 \frac{E t^4}{r_o^3} = \frac{4.6 \times 1.45 \times 30 \times 10^6 \times (.083)^4}{(3.75)^3} = 675 \text{ pounds}$$

This load is too high since 520 pounds was desired. To get a lower peak load, since the latter from Equation (7) increases as  $t^4$  (other things being equal) the

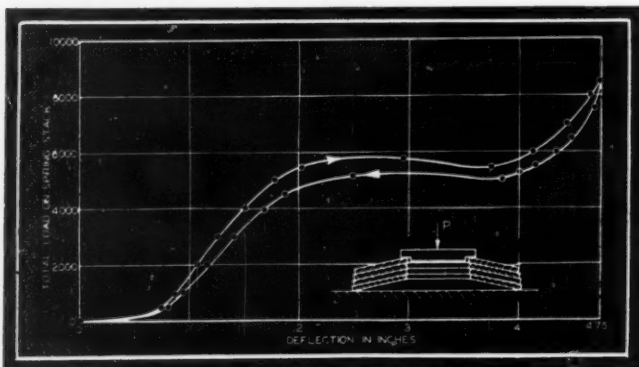


Fig. 10—Deflection test of stack of four steel Belleville springs (in inches, outside radius =  $4\frac{1}{2}$ , inside radius =  $1\frac{1}{4}$ , height = .212, thickness = .148)

thickness may be reduced in the ratio

$$\sqrt{\frac{520}{675}} = .935$$

Thus  $t = .0833 \times .935 = .078$  inch. For the same shape of curve we must keep  $h/t$  the same (2.5) so that  $h = 2.5 \times .078 = .195$  inch. At  $\frac{1}{4}$  inch deflection,  $\delta/t$  will be  $.25/.078 = 3.2$  which will bring us somewhat

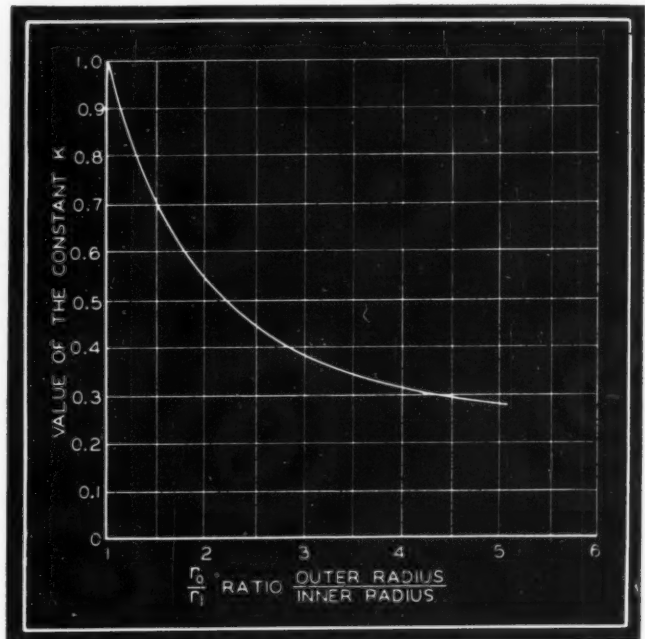


Fig. 11—Stress constant K for radially tapered disk springs

beyond the point on the curve for  $\delta/t = 3$ , but in this case this is permissible. Also the maximum stress will not be changed since from Fig. 8, for  $h/t = 2.5$ ,  $\delta/t = 3.2$ , the factor  $K_1$  is practically the same as for  $\delta/t = 3$ . From Fig. 5, for  $\delta/t = 3.2$ ,  $h/t = 2.5$  we obtain  $C_1 = 1.3$ . Since  $C_1 = 4.6$  at the peak load, the load when the spring is against the stop will be  $1.3/4.6 \times 520 = 147$  pounds.

### Radially Tapered Disk Springs

If the disk spring is made flat and has a thickness which is proportional to the radius, Fig. 3, as a first approximation the stress will be constant along a radius. This may be explained as follows. If a radial cross section rotates through an angle  $\phi$  (assuming no distortion of the section) then the radial displacement of a point on the surface at a radius  $r$  will be  $t\phi/2$  and the unit elongation  $t\phi/2r$ , where  $t$  is the thickness. By making  $t/r$  constant<sup>3</sup> the unit elongation and hence the stress will be constant.

The calculation of initially flat radially tapered disk springs may be carried out by using the same assumption as that discussed previously for calculating Belleville springs, i.e., during deflection radial cross sec-

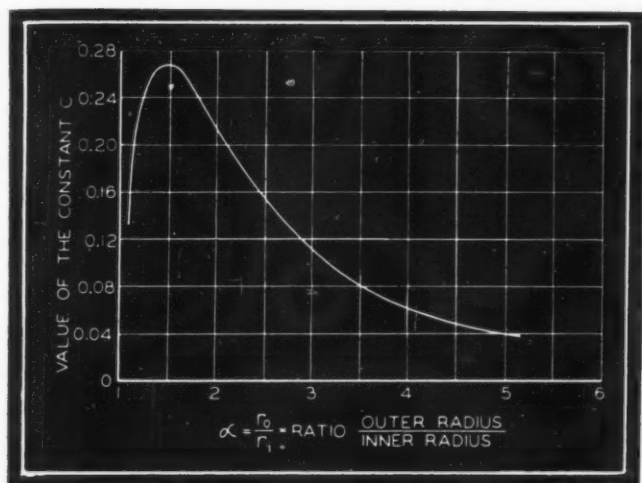


Fig. 12—Deflection constant  $C$  for radially tapered disk springs

tions rotate without distortion. This will yield an approximate solution. However, for this case a more exact solution, based on flat plate theory is available<sup>4</sup>. This indicates that the approximate solution is correct to within a few per cent for deflections in cases where the ratio of outside to inside diameter is less than 2.5. For stress, however, the error is considerably greater, amounting to about 25 per cent at a ratio  $r_o/r_i = 2$ .

Using the more exact theory, the stresses and deflections may be computed from<sup>5</sup>

$$S = K \frac{P}{t_i^2} \dots \dots \dots (11)$$

$$\delta = C \frac{P r_o^2}{E t_i^3} \dots \dots \dots (12)$$

where

- $S$  = maximum stress in the spring (this occurs at the lower inner edge)
- $\delta$  = maximum deflection at load  $P$
- $t_i$  = thickness of disk at inside edge
- $E$  = modulus of elasticity of the material
- $C$  } factors depending on the ratio  $r_o/r_i$  between
- $K$  } = outer radius and inner radius and may be read from the curves of Figs. 12 and 11 respectively

Numerical values of the constants  $C$  and  $K$  for various values of  $\alpha = r_o/r_i$  are given in Table I.

TABLE I

Stress Constant  $K$  and Deflection Constant  $C$  for Radially Tapered Disk Springs

$\alpha^* = 1$	1.25	1.5	2	3	4	5
$K = .985$	.819	.696	.536	.382	.315	.28
$C = 0$	.243	.271	.213	.11	.062	.039

\* $\alpha = r_o/r_i$

In the practical application of radially tapered disk springs, the load usually is applied at some little dis-

3. This expedient was suggested by W. A. Brecht of Westinghouse company.

4. The "Radially Tapered Disc Spring", by W. A. Brecht and the writer; Transactions, A.S.M.E., 1930.

5. It is assumed, in using these equations, that the deflections are not more than about half the thickness  $t_i$ . This will include most practical cases where initially flat springs are used.

tance inside the edges of the spring as indicated in Fig. 13. In such cases, it is advisable to figure the spring as though the load were applied exactly at the edge. The resulting stress is then multiplied by the ratio  $d/(r_o - r_i)$ , while the deflection is multiplied by the ratio  $d^2/(r_o - r_i)^2$  to take the inward displacement of the point of load application into account. This method will yield a better approximation to the maximum stress and the deflection at the point of load application.

If the deflection is larger than about half the thickness  $t_i$ , the load should be calculated from:

$$P = \frac{E t_i^3 \delta}{C r_o^2} \left[ 1 + \frac{1.5 \delta^2}{t_i^2 (\alpha^2 + \alpha + 1)} \right] \dots \dots \dots (13)$$

Since the second term within the brackets usually is small compared to unity, the deflection  $\delta$  may first be computed by using Equation (12), assuming the load is given. This calculated value for  $\delta$  is then divided by the term in brackets, which is

$$\left[ 1 + \frac{1.5 \delta^2}{t_i^2 (\alpha^2 + \alpha + 1)} \right]$$

This will result in a second approximation for the deflection  $\delta$  which will usually be sufficiently accurate. A check may be made by substituting in Equation (13).

The stress and deflection equations for initially flat radially tapered disk springs given here have been checked by numerous deflection tests and strain measurements on actual springs using Huggenberger extensometers<sup>4</sup>. Good agreement was found between test and calculated results.

Investigation shows that for a given load, thickness

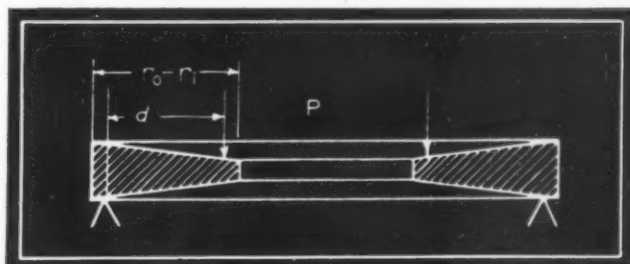


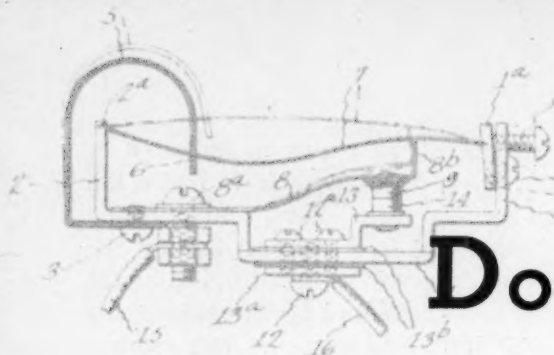
Fig. 13—Application of load in radially tapered disk springs

$t_o$ , and stress that the maximum flexibility for radially tapered springs is obtained by using a ratio  $\alpha = r_o/r_i$  of about 2. It is usually of advantage therefore to hold this ratio at this value, unless other design limitations dictate a different one.

Assume that it is desired to determine maximum stress and deflection for a radially tapered disk spring for a motor commutator, (Fig. 4). The dimensions are as follows:  $r_o = 9$  inches,  $r_i = 6$  inches,  $\alpha = 1.5$ ,  $t_i = \frac{3}{4}$  inch. Maximum load  $P$  is 90,000 pounds.

From Figs. 11 and 12 we find for  $\alpha = 1.5$  that  $C =$

(Concluded on Page 62)



# Don't Skimp on Your Pat

By George V. Woodling

**I**NGENUITY in designing and improving machines may well be supplemented by a knowledge gained in analyzing prior patents. Thorough working knowledge of old devices not only inspires the creation of new ones, but also enables the designer to begin his development work where the prior art left off. In this way there is no overlapping or duplication between a new development and prior inventions.

Experience reveals that much expense and wasted effort may be avoided if the designer informs the patent department or a patent attorney regarding developments instead of waiting until the final design is completed. The designer is benefited because the patent department through the making of patent searches can co-operate to guide new developments along lines which will avoid patent infringement. The patent department is helped because an intimate knowledge is gained of the new designs through their various steps. This co-operation enlarges the appreciation of the scope of the inventions and represents a considerable force in bringing about a broadening of the patent protection which might be obtained.

## Facilitates Purchase of Patents

Patent searches also are helpful in several other aspects. For instance, the knowledge gained through patent searches enables a manufacturing company to purchase adversely-held patents at reasonable figures, because after commercial activity is once started by the exploiting company, the bargaining value of such patents is greatly enhanced. In addition, a patent search enables the company to judge the merit of patents it is buying and cautions it against worthless ones. By purchasing worthwhile patents, the company is afforded immediate protection which tends to discourage infringing competition.

The United States Patent Office maintains a public search room, shown in Fig. 2, to facilitate the making

of patent searches. There more than two million United States patents are classified according to the various arts, including more than 300 general classes, and 3000 subclasses. Thus, the field of search may be limited to one or more subclasses. As an aid in locating pertinent patents, a "Manual of Classification" prepared by the patent office is used as an index or guide to give the general classes or subclasses. A facsimile of a page from the manual is shown in Fig. 3. This particular page relates to general "Class 200, Electricity—Circuit Makers and Breakers," which class contains 172 subclasses some of which are shown on this page. The subclasses vary in size and each may contain as many as several hundred patents. When they become too large, they are reclassified into additional subclasses.

## Initial Search Should Be Limited

In making a search, the field of search should be determined first with the object of limiting it to a few of the most fertile subclasses. For instance, in directing a search for the double snap switch shown in Fig. 1, the searcher would be likely to examine subclass 67, "Double Snap," listed under the general subject "Snap," see the page from the manual. If this subclass should fail to reveal any pertinent patents, the searcher then would direct his attention to one or more of the other related classes.

Searchers may take the classified patents from the file, leaf through them, and select those which appear to be the closest to the invention in question. Thus, a search upon the snap-over switch shown in Fig. 1 would reveal a group of patents, some of which are indicated on the first page of this article. All of these devices comprise in some form or other the provision of a double snap-over switch to accomplish a quick break of the circuit.

United States Patent Office searches comprise six distinct types:

- (1) Preliminary
- (2) State of Art
- (3) Assignment
- (4) Index
- (5) Infringement
- (6) Validity.

PRELIMINARY SEARCH: This type of search is

MACHINE DESIGN—March, 1939

# Pat Searches!

made prior to the filing of the patent application to forecast the likelihood of obtaining a patent and thus avoid the waste of money incident to the filing of applications upon inventions which cannot be patented. If the search indicates that the invention is old and unpatentable, the company saves the difference between the cost of the search and what the increased cost would have been if an application had been filed without a search.

Because of the general nature of preliminary searches, they cannot be strictly relied upon. A search may reveal that an idea is new, but when the inventor files his patent application he may then learn that the patent office has rejected the claims as unpatentable because of prior patents which the searcher did not find. Furthermore, pending applications are held in strict secrecy, and therefore patent searches do not disclose whether another inventor has a pending application upon the same subject. Thus a patent that is pertinent to an invention being searched may be granted a week after the search is made and thereby change the entire results of the search. For this reason it is not safe to rely too strongly upon preliminary searches.

In forecasting the possibility of obtaining a patent before making application, the proposed device under investigation is compared with the devices shown and described in the patents located in the preliminary search, and then the substantial identity between prior patents and the proposed device is observed. If the substantial identity between the prior patents and the proposed device is close, then the possibility of obtaining a patent presents a legal struggle. If on the other hand there is a wide departure between the identity of the prior patents and the device under consideration, the possibility of obtaining a patent assumes a brighter outlook.

## Opinions Differ Regarding Patentability

An important stage in connection with preliminary searches that should be stressed at this time is the problem of interpreting border-line cases. Two or more attorneys may examine the patents found in the preliminary search with reference to the device under investigation but, because of the weight given to different factors, each may present a different

opinion as to the degree of patentability. A mistake in judgment, advising a company not to file a patent application, may result in considerable loss.

Often a question is asked regarding the propriety of filing a patent application without making a search, in the hope that there is nothing like the new device in the patent office and that a search in such a case would be unnecessary. First of all it should be understood that the mere fact that a proposed invention cannot be found on the market is no proof whatsoever that it cannot be found in the patent office. It is difficult to set forth an all-inclusive answer to the question, but the following considerations (as discussed in the author's book *"Inventions and Their Protection"*) may be used as a general guide.

It usually is desirable to make a patent search before filing an application if the problem which the proposed invention solves is

- (1) Old and generally well known, and the so-

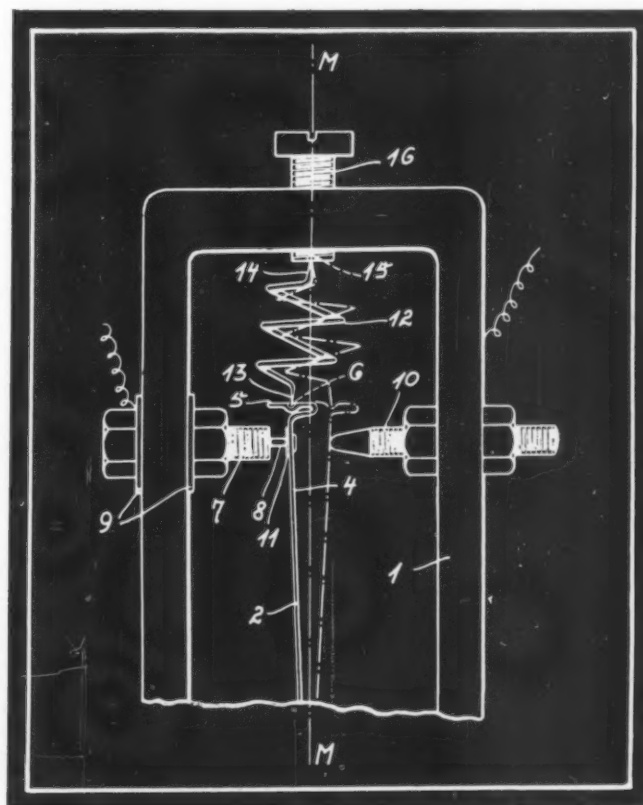


Fig. 1—Typical part, a double-snap switch, for which search is being undertaken

lution is such that others are likely to solve the problem in the same way

- (2) Old and generally well known, and the solution to the problem comprises but a "single" thought.

It ordinarily is unnecessary to make a patent search before filing application if the problem which the proposed invention solves is

- (1) Old and generally well known, and the solution is the reverse of that which other persons would be likely to attempt in order to solve the problem
- (2) Old and generally well known, and the solution to the problem involves complex thought and the co-ordination of several ideas
- (3) Old and generally well known, has baffled those skilled in the art, and the solution to the problem is discovered by pure accident
- (4) Old and generally well known, has baffled those skilled in the art, and the solution involves a long series of tests to obtain the exact ratios among the various parts of the invention
- (5) New and there has not as yet been sufficient time for the patent office to grant any patents. A search would not reveal subject matter contained in pending applications, because they are maintained in strict secrecy
- (6) Solved by one who has played a prominent part in the development of the specific field and is well acquainted with all of the recent developments.

STATE OF ART search is broader in scope than a preliminary search and ordinarily is required to assist the engineering department in planning a new line.

It usually is made when the department has not as yet developed any definite ideas regarding the design of the new machines. The purpose of such a search is to give a general idea of the patent situation regarding proposed new designs before going ahead with actual details. This prevents an overlapping or duplication of the new developments over prior devices. While making a state of art search, the searcher reviews several relating subclasses to give the engineering department a wide and general knowledge of the field.

**ASSIGNMENT SEARCH:** This is made to ascertain the present recorded owner of a particular patent. Such a search is advisable when a company desires to acquire rights under certain patents to give greater assurance that it is dealing with the proper owner. These searches give the recorded change in the title of the patent from the inventor to the present recorded owner.

#### Index File Names Patentee

**INDEX SEARCH:** Made to determine what patents have been issued to a particular inventor or company. The index file at the patent office contains an alphabetical list of patentees and corresponding patent data from which the searcher may obtain sufficient information to order copies of the patents. Thus, for example, the number of patents that have been issued to the XZY Co. can be found by making an index search against the particular company.

**INFRINGEMENT SEARCH:** Determines if a proposed device or improvement for manufacture and sale will infringe a claim or claims of an unexpired patent. The fact that the manufacturer may have obtained a patent upon the proposed device does not free him of infringement. It still may be necessary for the manufacturer to conduct an infringement search to make sure that no patent difficulties will arise after

Fig. 2—Investigation of hundreds of patents is carried out daily at this search room of the patent office



<b>199. TYPE CASTING—Continued.</b> Integral line Casting mechanisms 63 Matrices 64 Distributor features, 65 Multiple character, 66 Special design face, 67 Space bands 68 Wedge 69 Separate type 70 Surplus-type supply machines, 71 Individually movable-matrix machines 72 Releasing matrix, 73 Rotary-matrix-carrier machines, 74 Pattern control, 75 Slide-matrix-carrier machines 76 Two-way movement 77 Pattern control, 78 Keyboard control, 79 Matrix case, 80 Casting mechanisms 81 With finishing mechanisms 82 Mold-side-ejector mold, 83 Two-part mold, 84 Mold-side-ejector mold 85 Low quad, 86 Moving mold, 87 Two-part mold, 88 Moving mold, 89 Moving mold, 90 Squirt preventers, 91 Molds 92 Mold-side ejector 93 Low quad, 94 Two part, 95 Deliveries, 96 Matrices.	<b>200 ELECTRICITY—CIRCUIT MAKERS AND BREAKERS.</b> Definitions in Bulletin 47. 1 Multiple-circuit control 2 Loop, 3 Combined thermal current, 4 Combined pivoted and reciprocating contact, 5 Multiple switch, 6 Pivoted contact 7 Combined types, 8 Radial contact pressure 9 Plural switch, 10 Arc extinguishing and preventing, 11 Dial type 12 Electromagnetic release 13 Plural switch, 14 Plural switch, 15 Knife blade, 16 Reciprocating contact, 17 Operating means 18 Plural switch. 19 Periodic 20 Combined 21 Rotary and cam 22 Adjustable, 23 Multiple contact 24 Rotary 25 Adjustable, 26 Radial contact pressure, 27 Cam operated, 28 Rotary 29 Adjustable, 30 Cam operated 31 Adjustable, 32 Liquid contact. 33 Retarded 34 Dashpot,	<b>300. ELECTRICITY—CIRCUIT MAKERS AND BREAKERS—Contd.</b> Retarded 35 Clock train 36 Rotary 37 Multiple contact, 38 Cam operated, 39 Latch trip 40 Motor release, 41 Weight release, 42 Unauthorized-use preventing 43 Permutation switch, 44 Lock 45 Permutation. 46 Pattern-sheet controlled. 47 Limit switch. 48 High-potential type. 49 Pole switch. 50 Interlocking. 51 Combined plug. 52 Special application 53 Valve, 54 Door or sash, 55 Lock, 56 Indicating instrument, 57 Letter box, 58 Tire, 59 Lever or wheel shaft, 60 Portable light, 61 Incubator Snap 62 Auxiliary snap contact, 63 Rotating contact 64 Push or pull, 65 Detent 66 Radially movable, 67 Oscillating contact 68 Double snap 69 Cam or wedge release 70 Two button,	<b>300. ELECTRICITY—CIRCUIT MAKERS AND BREAKERS—Contd.</b> Snap Oscillating contact Double snap Latch trip Two button, Two button, Single snap Latch trip, Two button, Reciprocating contact Cam or wedge release, Latch trip. Suspended-wire controlled. Centrifugal. Fluid pressure Piston, Diaphragm. Float. Weight Treads. Electromagnetic Combined thermal current, Nonclonable, Periodic, Alternating current, Motor, Polarized, Predetermined current, Magnetic-pull adjustment Automatic, Retarded, Multiple magnet Aligned Core armature, Core armature, Multiple coil, Multiple armature, Multiple contact,
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Fig. 3—Facsimile of page from the manual of classification of patents. Note "Double snap" under classification 67

the proposed device is introduced on the market. New patents can be granted to the company on improvements, and thus competitors can be prevented from manufacturing or selling machines with these improvements. However, the company may not be able legally to manufacture and sell the improved machines without a license agreement under earlier dominating patents which cover basic factors.

VALIDITY SEARCH is made to determine the validity or nonvalidity of the claims of a specific patent. Probably the most frequent use of a validity search is in a patent law suit wherein the defendant endeavors

to prove to the court that, in view of the patents found in the validity search the claims in the plaintiff's patent are invalid, notwithstanding the fact that the patent office allowed the claims.

Some of the larger manufacturing corporations keep a complete file of all the patents pertaining to their products and a complete search may be made in the company's patent files without conducting a search at the patent office. The company's patent files usually are kept up to date by ordering copies of all patents which relate in any respect to the company's business.

## Mile-Long Machine Performs Continuous Process

(Concluded from Page 29)

at the bottom of the machine are what is known as twister tables, grouped in series of five, supporting 100 rayon twisting spindles over an overall length of 44 feet. The tables are counterweighted and suspended by pulleys and shafts on each side of the machine frame and operated from the cam at the drive end.

All motors are flange mounted, and chain tensions are maintained by spring-backed automatic idlers. Force feed lubrication from an oil sump in the bottom of each casing is provided for all chain drives.

In connection with materials not previously discussed, it should be mentioned that beneath and back of each process reel is a molded hard rubber tray. Distribution and reclaiming of processing liquors to and from the reels would have been difficult without the development of such a chemically resistant tray. Molded hard rubber pipe and fittings also contribute

to the economical circulation system for many of the liquors.

In the reels as well as in other small shaft mountings, use of self-lubricating bearings reduces lubrication and maintenance costs and insures reliability.

It may be said in conclusion that the overall problem involved in the design and construction of this continuous machine required balancing the first cost of the equipment and its probable cost of operation and servicing against the handling expense eliminated and the contemplated improvement in the quality of the product. As has been discussed, cost of construction was lowered considerably by welding easily fabricated steel sections. Servicing costs have been held down by providing overall access for repairs and a high degree of parts interchangeability. And through the very development of a continuous automatic machine the total elapsed time for extruding, coagulating, processing, drying and twisting is cut to about six minutes, against as much as four or five days using batch treatment.



## How to Reduce Surface Fatigue



By S. Way

*Westinghouse Electric & Mfg. Co.*

Fig. 1—Top — Appearance of surface failure on roller bearing race under test. Fig. 2—Left — Characteristic failure on ball bearing race

**I**N THE design of machine parts it is not sufficient to give consideration only to the ability of the parts to carry loads without danger of fatigue or undue distortion. The capacity of the surface metal to withstand the particular conditions to which it may be subjected must also be considered. Typical examples involving these problems are antifriction bearings and gears.

A bearing race as a structural element may be amply strong to resist deformation or rupture as a whole, yet if it cannot withstand the contact stresses in the immediate vicinity of the loaded areas under the balls or rollers it is subject to failure. Similarly, gear teeth may be amply strong as far as carrying bending stresses are concerned but, if the surface metal is unable to carry the contact pressures between teeth, pitting results which may be destructive.

Design of a machine part to enable the surface metal

to withstand conditions peculiar to it requires an understanding of the type of failure that might be expected. The events, whether chemical or mechanical, leading to a breakdown of the surface material should be thoroughly understood in order to design parts properly. It is the purpose of this article to emphasize the nature of, and the main factors influencing, one particular class of failure, namely, surface fatigue due to repeated contact stresses.

Surface fatigue is one of several types of surface failure which may occur when two metal surfaces are in rolling or sliding contact. These failures may be listed as follows:

- (1) Scoring, or the removal of material from one body due to the scratching by the protuberances of the other
- (2) Abrasion, or the removal of material

from one or both of the bodies because of the cutting action of particles between them

(3) Seizing, followed by tearing out of particles

(4) Flaking, or progressive corrosion accompanied by the breaking off of oxide and metal particles. This happens mainly on unlubricated surfaces

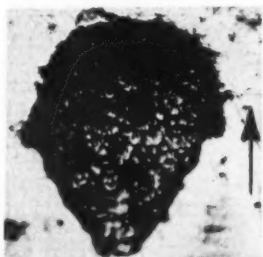
(5) Pitting, or surface fatigue.

What is commonly called "wear" is usually a combination of several of these forms of failure and possibly some others. The particular type of surface failure that occurs on a machine part will depend on many factors such as the shape of the bodies, the surrounding medium or lubricant, the relative amounts of sliding and rolling, the speed, the load and the physical and chemical properties of the materials.

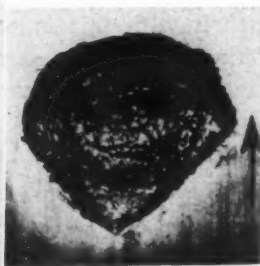
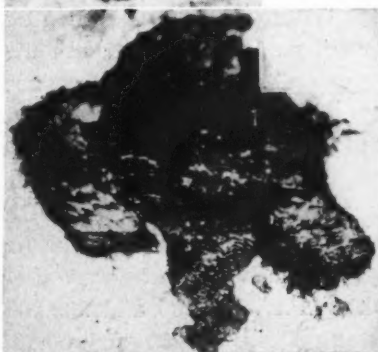
### Examples of Surface Failures

When two metal surfaces are in rolling contact, with which may be combined a moderate amount of sliding, and when the surfaces are lubricated with a liquid, the type of failure that is apt to occur is surface fatigue. Thus, the surface failure of gear teeth, if not due to seizing or scoring, and the failure that takes place on balls, rollers and races of antifriction bearings are surface fatigue failures. Like other fatigue failures, surface fatigue is characterized by the formation of a fatigue crack due to repeated applications of the load on the region of contact. Several million load applications may be necessary to start the crack. The final appearance of the failure depends to a large extent on the shape of the bodies and their physical properties.

The first example, *Fig. 3*, shows a surface fatigue failure, or pit, on a steel gear tooth of medium hard-



*Fig. 3*—Left—Pit on gear tooth. *Fig. 4*—Left, below—Failure on roller of spherical roller bearing. *Fig. 5*—Below—Pit on roller bearing. Arrows show direction of rotation. Magnification, 14X

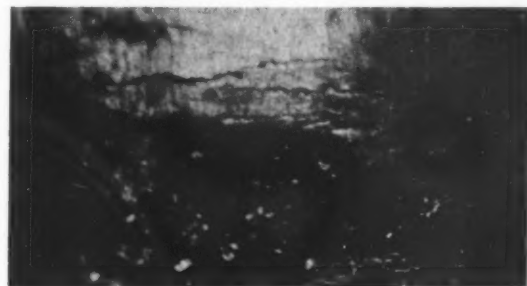


ness. This pit occurred at a location where there was sliding between the mating teeth; however, similar pits are observed at the pitch line where there is no sliding. The second example, *Fig. 5*, shows a pit produced on one of a pair of cylindrical rollers running together in pure rolling contact. The rollers were of a material similar to the gear tooth of *Fig. 3*. Two characteristic features of the pits shown in *Figs. 3* and *5* should be noted: The general form of the pit is fan-shaped, and the pits are always oriented the same way with respect to the direction of motion of the load, shown by the arrow.

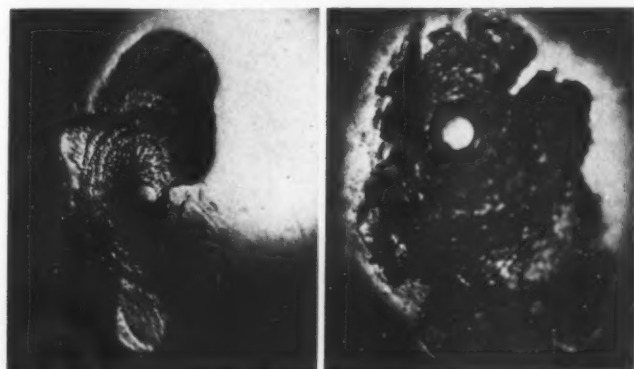
The third example of surface fatigue, *Fig. 4*, shows a pit on a roller from a spherical roller bearing. Here, the characteristic fan shape is missing. In general, pits on very hard materials are of quite irregular shape.

Examples in *Figs. 1* and *2*, show pitting of a roller bearing race and a ball bearing race respectively, after destruction tests. In such cases the pitted areas are apt to be quite large, because the pitted regions appear to grow continually as a result of the shearing off of material at the edge of the pit. This shearing action is illustrated in *Fig. 6*, where cracks parallel to the edge of the pitted region can be seen. This progressive growth does not take place in the case of the gear tooth type of pitting shown in *Figs. 3* and *5*. The latter pitting results from the separation from the main body of material of a single particle, following the growth of a crack.

Another example of pitting of yet a different form is shown in *Fig. 7*. Failures like this occur on the balls of self-aligning or deep groove ball bearings. The pit



*Fig. 6*—Progression of crack on ball bearing race. Magnification 34X



*Fig. 7*—Pits developing from surface cracks on ball bearings. Magnification, left 10X, right 14X

has an elevated summit in the middle, the surface of which is the original surface of the ball.

These examples illustrate the point that the final appearance of a surface fatigue failure depends on the nature of the contacting bodies. To gain an understanding of how these failures take place it is necessary to study them at an early stage. When this is done it is found that in beginning they have certain common features.

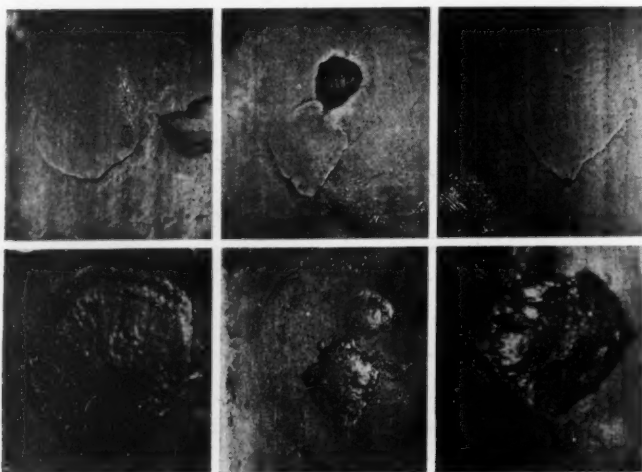
### Cracks Start at Surface

Before the pit is formed there can be seen at the surface a small fatigue crack. Some of these cracks and the pits that resulted from them on test rollers are shown in *Fig. 8*. A surface fatigue crack on a ball bearing race is shown in *Fig. 9*. The cracks on gear teeth and test rollers have been observed to start always on that side of the future pit which first meets the oncoming load.

Pitting fatigue cracks can also be studied at an early stage by making sectional cuts through them as soon as they are observed at the surface. When the sectioning plane is perpendicular to the axis of rotation, the shape of the crack below the surface can be seen, and the cracks are found to slope obliquely into the metal, as shown in *Figs. 10 and 11*. It is of interest that the surface fatigue cracks on gear teeth, test rollers, and ball and roller bearing races all slope obliquely into the metal at an acute angle to the surface. Furthermore, the direction of slope of these cracks for the case of gears and rollers has always been found to bear the same relation to the direction of the approaching load. There is evidence that the ball and roller bearing pitting cracks also have a uniform orientation.

Examination of the pits on the balls shown in *Fig. 7* indicates that the cracks probably started at the central summit and worked out radially. The formation of such a crack can be explained by a study of

\* S. Timoshenko, *Theory of Elasticity*, p. 344.

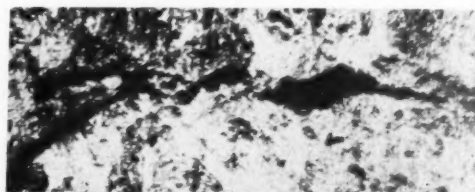


**Fig. 8—Initial cracks and subsequent fan-shaped pits on rollers. Magnification 11X**

the Hertz system of contact stresses between ball and race. This theory\* shows that at the edge of the contact area, in case it is circular, there will be a radial tensile stress of magnitude  $0.133P_{max}$  and a circumferential compressive stress— $0.133P_{max}$  where  $P_{max}$  is the maximum compressive stress in the contact area. There is thus a shearing stress at the edge of the contact area of magnitude  $0.133P_{max}$ . Greater shearing stresses occur below the surface, but only in regions where there is also high hydrostatic compression, and it is therefore questionable if these shearing stresses are dangerous as far as fatigue is concerned. At the edge of the contact area on the surface there is no hydrostatic compression.

Location of the start of the surface fatigue cracks is of importance in throwing light on the stresses responsible for the failure.

Consider the stresses that exist in a cylindrical body



**Fig. 9—Appearance of ball bearing race failure. Magnification 136X**

in contact with another. Let the width of the contact area be  $2b$ . If the bodies are perfect cylinders and the tangential forces in the contact area are distributed as a semi-ellipse:

$$P = P_{max} \sqrt{1 - \frac{y^2}{b^2}}$$

where  $y$  is the distance from the center of the contact area. The maximum shearing stress, which is found at depth  $0.786b$  below the surface, is of magnitude  $0.300P_{max}$ , and acts on planes making angles of 45 degrees with the surface and parallel to the contact bond. When the cylinders are rolling, the greatest variation in shearing stress occurs on a horizontal plane at depth  $0.500b$ , and varies from  $+0.25P_{max}$  to  $-0.25P_{max}$ .

From the standpoint of fatigue one might guess that the material at depth  $0.500b$  is in the most severely stressed condition. To study this matter experimentally, the following tests were made. Steel cylinders  $1\frac{1}{2}$  inches in diameter, approximately, were given a good polish with fine emery paper and alumina powder. These rollers were run together in pure rolling contact with normal pressure. The material was quenched and tempered 0.40 per cent carbon steel of 240 VPN hardness, which has a shearing endurance limit of about 32,000 pounds per square inch. Loads were used in successive tests making  $P_{max}$  165,000 and 202,000, and the reversed shearing stress 40,200 and 50,500

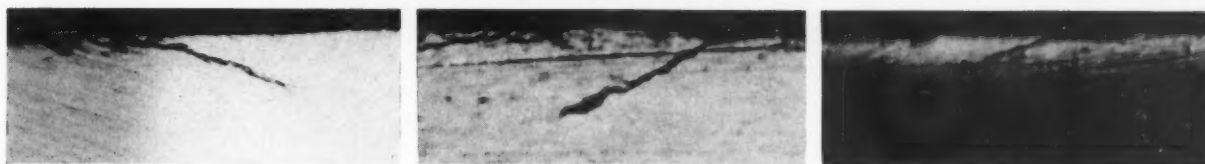


Fig. 10—Above—Surface cracks on roller (340X) at left, on ball bearing race (680X) in center, and on roller bearing race (340X) at right. Fig. 11—Below—Development of crack on gear tooth. Magnification 140X



pounds per square inch. Over 8.5 million cycles were run in each test. At the end of the test at higher load there was no sign of pitting. Later, one of these rollers was sectioned to see if any fatigue cracks had developed in the region at depth  $0.500 b$ . None were found even though the reversed shearing stress was 55 per cent above the shear endurance limit. It would appear that a very high alternating shearing stress below the surface in a region of high hydrostatic compression is not necessarily dangerous as far as fatigue is concerned.

It was found that if rollers of the material just discussed were given a ground finish, instead of being polished, pitting would take place at a load of about 85,000 pounds per square inch for  $P_{max}$ . In this case the theoretical reversed shearing stress below the surface is only 21,200 pounds per square inch, which is below the shear endurance limit. By studying the cracks in section it is found that they start much closer to the surface than  $0.500 b$ . We are thus led to the belief that pitting fatigue cracks are not due to the theoretical Hertz stress system for smooth cylinders, but to the stresses due to the contact of the waves and protuberances on surfaces of rolling bodies.

Cracks have been observed in section extending less than .001 inch below the surface. It is not certain whether these cracks start at the surface or somewhere below the surface in the layer .001 inch thick. However the experiment with the polished rollers is indication that cracks do not start below the surface.

#### Effect of Oil on Crack

Imagine two rough cylinders in contact. The contact area will not be the theoretical band of width  $2b$ , but will be a series of island areas. We have spoken already of the tensile stress at the surface and the possibility of fatigue failure starting at the surface in the case of circular and elliptical contact areas, in connection with the pitting of ball bearings. The

roughness of the surfaces of the cylinders is responsible, therefore, for stresses that might cause failure to start at the surface.

If cylindrical rollers be run together without oil, and with pure rolling contact, the wear will be negligible but the surfaces will become oxidized. If oil is added after several million cycles have been run at a load above the pitting endurance limit, pitting will take place in a short time. This indicates that small fatigue cracks were present in the unlubricated rollers, which did not grow to serious proportions until oil was added.

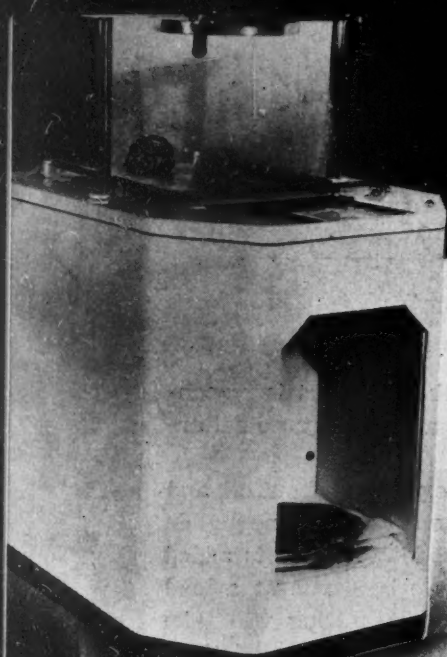
An explanation of these phenomena, and of the fact that all mature pitting cracks are observed to slope into the surface in the same direction, is furnished by the hypothesis that the oil enters the fine fatigue cracks and, by the virtue of the presence of the approaching opposite roller, becomes trapped in those which are favorably oriented. The pressure in the oil so trapped might well reach a gigantic value and cause the crack to be driven deeper into the metal.

#### Methods to Minimize Fatigue

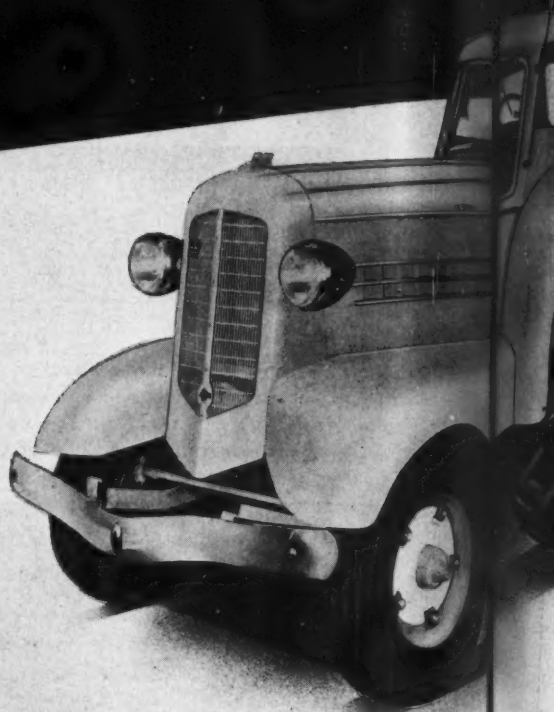
Observations of surface pitting mentioned above enable conclusions to be drawn as to the direction in which we should look to discover ways of minimizing surface fatigue. First, the failures are recognizable as fatigue failures, and this means that materials of sufficiently high endurance limits should be used to prevent them. Aside from increasing the strength of the material, the only way to avoid failures is to reduce the stresses. For parts in danger of surface fatigue, this can be done in several ways. Assuming the total load applied in the contact area is given, the stresses resulting from the load application can be reduced by using

- (1) Smaller surface curvatures to reduce the contact stresses in and around the contact area
- (2) Material of low modulus of elasticity which causes a wider distribution of the load and lower contact pressures
- (3) Smoother, more accurately finished surfaces to avoid concentrations of load on bumps and high spots
- (4) Lubricant of sufficiently high viscosity to relieve the concentrated pressures on surface high spots.

To know the relation of factors such as surface curvatures, modulus of elasticity, surface finish and lubricant properties to the endurance limit required for rolling bodies to be free from surface fatigue, test data must be obtained under controlled conditions.



Proper timing and automatic positive operation of all correlated parts in the Holly hamburger patty maker (left), constituted a notable design problem. The transparent mold lining sheet seen at top is pulled under the mold head on each downward stroke and brings up the completed patty with an underlying portion of wax paper. Paper is cut, trap doors open and the patty drops into the hopper at the front of the machine. Case is baked white enamel, moving parts are chromium plated

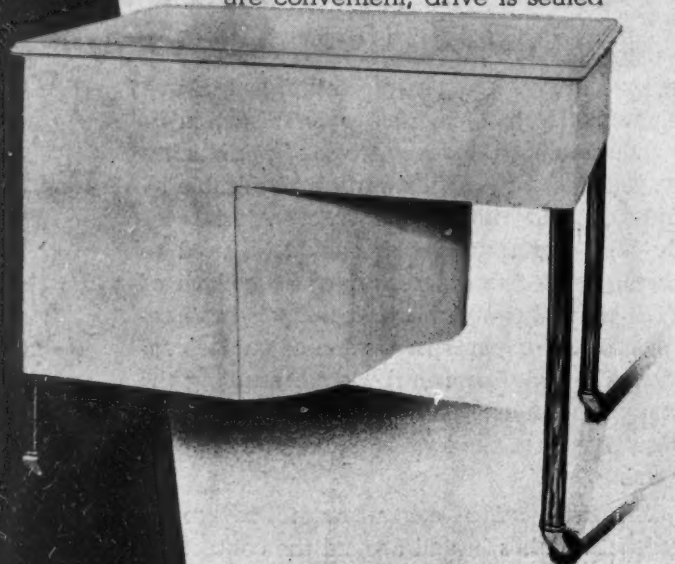


A washing machine has been incorporated in a kitchen table in the Voss Kitchen Table Washer (below). Cradle of machine permits wringer to be folded down into rinse tub so the table top may be placed in proper position. The washer is finished throughout in smooth hard baked enamel except for chromium-plated legs. Controls are convenient, drive is sealed

## Design Features In New Machinery

A Pictorial Presentation of Recent Machinery from the Standpoint of Design

(For new machine listing see page 86)



The Wood heavy duty Autoshafer for newspaper plates (below) has a one-piece cast frame, and weighs 3½ tons. Compressed air blows sawdust from face of plate as it enters the arch. Its location eliminating danger of water splash, the motor is direct connected. The shear pin on the shaving knife bar is easily accessible. Smooth exterior contours have been designed in this large machine

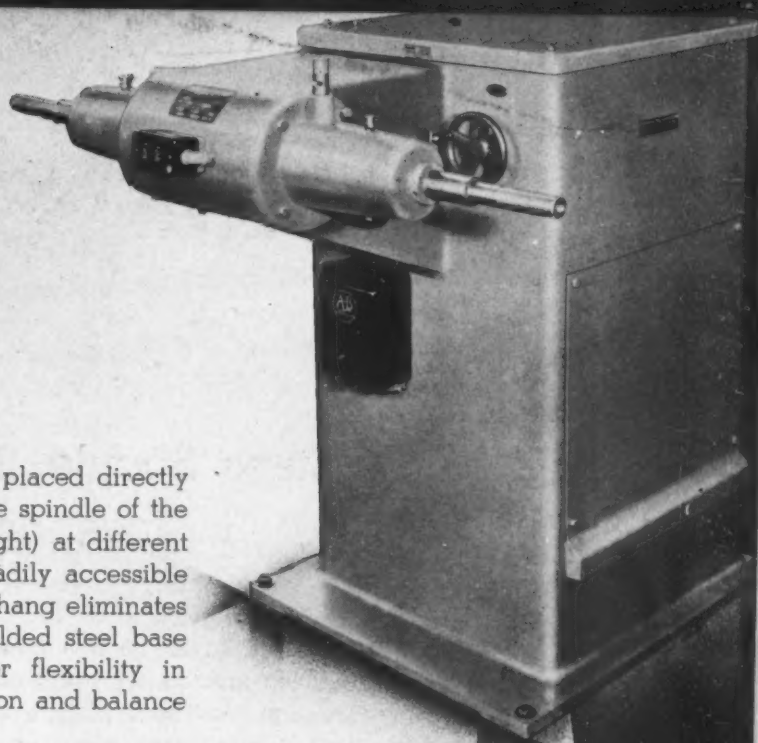


Automatic time control, consisting of a time clock and a thermostat, shortens the toasting period on the Utility Toastswell automatic toaster (above) as it warms up. A selective automatic lift permits adjustment so the toast will be raised a short distance and remain hot or will be raised half-way out of the toaster. Finish is chromium, handles and feet are plastic

An accurate  
clock and  
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Cab of the Minneapolis-Moline Comfort tractor (left) is all-steel with safety glass throughout. Transmission offers five speeds forward, one reverse. Entire inner portion of transmission is protected against dirt by felt seals, with leather seals retaining oil. Variable speed flyball type governor is fully enclosed, lubricated by engine oiling system, pedal-controlled

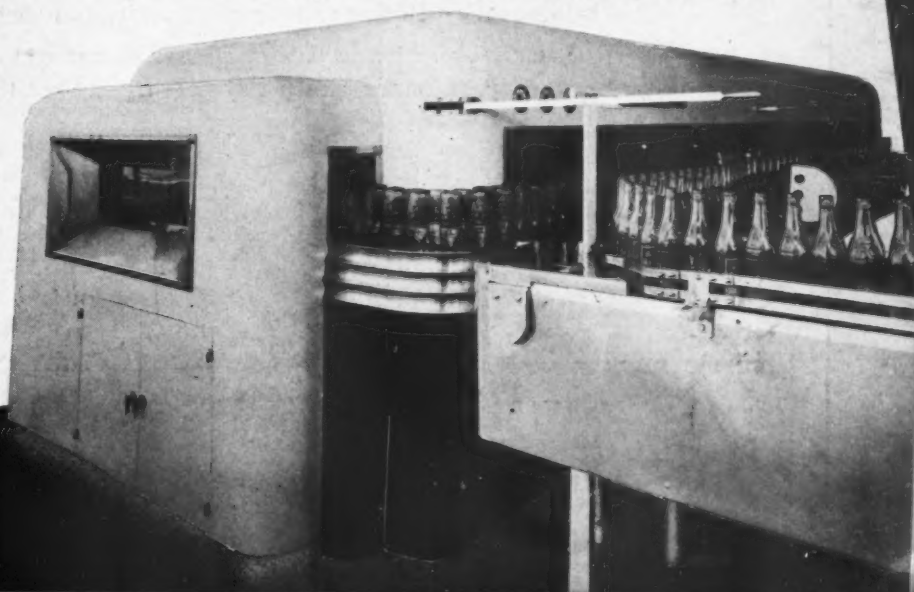


Built-in variable sheaves, placed directly above the motor, drive the spindle of the Crown polishing lathe (right) at different speeds. All parts are readily accessible for inspection. Long overhang eliminates wrench adjustments. Welded steel base is said to permit greater flexibility in attaining weight distribution and balance



An entirely enclosed cam mechanism driven through a worm gear speed reducing unit by a one-twentieth horsepower motor is the key to operation of the Monarch Pin-On machine (left). It feeds special plated pins by extracting them from a paper strip and then drives them through price tag tickets in a manner which does not snag merchandise or harm hands. Finish of the machine is black crackle with all exposed parts except the covers in chromium

Start and stop motion of the Miller-Hydro bottle washer and sterilizer (below) must be exact and is accomplished by a drive that moves the chain of cups to a predetermined distance and locks. To eliminate splashing of hot alkali bottle-cleansing solutions, Barnes & Reinecke, industrial stylists, designed a housing completely enclosing the machinery with three plate glass windows on the side permitting a clear view of the operation. Sections were designed for ease of fabrication and interchangeability. Black and white portions are baked enamel. Horsepower consumption was reduced 50 per cent through installation of centrifugal pumps



An accurate alternating current electric clock and a standard broadcast radio have been built into the International Autotime radio alarm, (below). The radio turns on and off automatically at any preset time. Simple, attractive cabinet is finished in burl walnut



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## Steps Should Be Taken to Reduce Engineering Unemployment

**E**STIMATES indicate that upwards of fifty per cent of the country's engineering graduates are not engaged in engineering work; further, that a large proportion of these, about sixty per cent, cannot find employment of any kind. These figures apply, of course, to the depression period but, as stated by Dr. D. B. Steinman, past president of the Society of Professional Engineers, ". . . . in normal times there are plenty of recent graduates begging for jobs in engineering offices, even without salary!"

As long as such conditions obtain, whether in normal times or depressions, the profession of engineering cannot hope to attain the high level to which it is entitled. Nor will salaries reach, or be maintained at, a point commensurate with the hard work and years of training required in the development of successful engineers.

One basic reason that accounts for the current unemployment among engineers, and for the fact that many have been compelled to seek other types of work, is overcrowding. Starting with the graduates of technical high schools who wish to follow engineering, right through to the students taking post-graduate courses, far too many men seem to feel that engineering holds unlimited promise. This attitude unquestionably is fostered by the romantic writings that appear from time to time fallaciously picturing the work of engineers and entirely minimizing the years of concentrated labor and effort that have gone before.

It's high time that a more practical attitude toward engineering be adopted by all. We have a host of good engineering schools and it is hoped these will maintain a reasonably high enrollment rate. But whether as many graduates should be turned out from these schools is another matter, particularly if all the graduates really expect to make a successful living. Yet an engineering education fits a man for progress in later life, generally speaking, as well as any other course. So perhaps it would be unfair—even unwise—to try to limit enrollment as do some of the other professions. At the same time, requirements for graduation might well be stiffened considerably, and thus a higher percentage of graduates turned out whose aptitude and acquired qualifications might lead them to believe they will find satisfactory openings in their chosen profession.

Only by action of this or similar nature can engineers expect to attain the respect, prestige and prosperity that rightly are theirs!

# Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

## Commends Thermal Stress Article

*To the Editor:*

**M**R. SHEPHERD'S article "Why Thermal Stresses Cause Failure of Parts", in your February issue, page 47, should be of particular value to MACHINE DESIGN'S readers because it discusses qualitatively the mechanism of heat failures and does not obscure the physical picture by introducing involved mathematics. A conceptual knowledge of heat stresses is indispensable to the satisfactory design of parts which have to withstand both mechanical and thermal forces.

The author points out that ribs should be designed for heat dissipation and not for strength. In line with this thought the machine designer should avoid the use of nonuniform sections for parts required to transfer heat, since these heat dams always result in a stagnation of flow and cause excessive gradients conducive to failure. The failure of parts exposed to the working fluid of an internal combustion engine in many cases can be attributed to the presence of such heat dams.

Fluctuation of the boundary temperature (G. Eichelberg, FORSCHUNGSARBEITEN, No. 263, 1923) has been shown to be a small percentage of the fluctuation of the gas temperature in the cylinder. Furthermore, this fluctuation is inversely proportional to the square root of the frequency, so that the cyclic thermal stresses in a moderate or high speed internal combustion engine are not as important as those due to the mean gradient.

In regard to suitable materials, the manufacturer of an aircooled outboard motor has solved this problem by the use of die castings. The success of the design shows that some die cast materials have favorable thermal properties in this particular application.

—K. E. BISSHOPP  
Beloit, Wis.

## Art and Styling—Mutual Influences

*To the Editor:*

**A**S AN interesting side light which has occurred to me and which might prove to be a good subject for discussion, I have noticed that the machine affects art and architecture to a considerable degree and on the other hand that present designs of machines

are influenced by artistic and architectural considerations. It may be that places are being exchanged and the artists of today will become the machine designers of tomorrow, with machine designers of today the artists of tomorrow. At any rate we machine designers are concealing the gears, links, and other moving machine members, whereas the so-called modern art seems to like the idea of dumping these in a pile and depicting them thus in their paintings!

—R. S. ELBERTY  
Landis Tool Co.

## Raises Question on Invisible Glass

*To the Editor:*

**T**HE article on "invisible" glass on the Topics page (26) of your February issue has me stumped. I read a similar article . . . and did not agree with the theory expressed . . . I am beginning to wonder just what the truth of the matter is.

Your explanation that the light reflected from the front of the film and that reflected from the rear side of the film, (the front surface of the glass) becomes invisible when reflected because the components are out of phase, sounds perfectly logical. The fact that this reflected light is invisible to an observer, however, seems to have no bearing on the question of how much light will be transmitted through the glass.

Would not a more logical explanation be that the amount of visible light reflected toward an observer is decreased from 25 per cent to less than one per cent, thereby rendering the surface of the glass practically invisible, while the amount of light actually passing through the glass is the same as before, 75 per cent, or perhaps slightly less than this because of the losses of light in passing through the film?

My interest in this matter is largely academic and I do not know anything about the glass except the description . . . However, I would appreciate it if you could set me straight on this matter.

H. A. WILCOX  
Automatic Signal Corp.

**Editor's Note:** Other questions have been asked regarding the manner in which the films eliminate reflection. These will be correlated and the answer published next month.

# Men of Machines

**H**IS extensive knowledge of the automotive industry gained through his various connections as designer and chief engineer of automobile companies will be valuable to David E. Anderson in his new position as research engineer of Holley Carburetor Co.

Prior to his last connection as chief engineer of Bohn Aluminum Brass Corp., Mr. Anderson's experience included design work with Wisconsin Motor Co., A. C. Clark Co. and Brush Runabout Co. Later he transferred to U. S. Motors Corp. as assistant division engineer. As chief engineer he then joined Falls Machine Co., and later became designer with Cadillac Motor Car Co. In 1916 he joined Essex Motors as designer, later becoming assistant chief engineer. He afterwards returned to Cadillac company as engine designer, remaining until 1926 when he joined Bohn Aluminum.

DAVID E. ANDERSON



WEBSTER N. JONES

**T**AKING a prominent part in the engineering curriculum of Carnegie Institute of Technology, Pittsburgh, Dr. Webster N. Jones, who came to the institute in 1932 following a teaching and industrial career, has been elected president of the American Institute of Chemical Engineers.

Dr. Jones received his A. B. and M. A. degrees from the University of Missouri, and later, his Ph. D. from Harvard. His professional career, from 1908-1919, includes teaching at the universities of Purdue, Harvard, Maine, Missouri, Montana, and Radcliffe college. Following the war, he joined the B. F. Goodrich Co. where he remained until becoming connected with Carnegie Institute in 1932 as director of the college of engineering. He has published numerous papers on technical subjects and on engineering education, as well as editing the Annual Survey of American Rubber Chemistry.



U. A. WHITAKER

**I**N HIS new appointment as director of research and standards of American Machine & Foundry Co., U. A. Whitaker, formerly director of development and design of the Hoover Co., undertakes an assignment of broad nature. This involves design, cost estimating, manufacturing and patent department activities.

Graduating with a mechanical engineering degree in 1923 from Massachusetts Institute of Technology, and later obtaining one in electrical engineering from Carnegie Institute of Technology, Mr. Whitaker's first connection was with Westinghouse Air Brake Co. as special engineer. During his last two years with this organization he specialized in preliminary development and planning, and worked with the patent department in coordinating patent developments and engineering. He remained for seven

# 3 "WAYS" agree on 1 FACT

MODERN METALS REDUCE OPERATING COSTS

## RAILWAYS



Railways, highways and waterways present varied operating problems. But each transport system agrees operating costs can be reduced by utilizing modern materials—such as Nickel alloyed cast irons.

For new equipment or replacement parts, take full advantage of the money-savings made possible by modern metallurgy and engineering. Make each ounce, each inch of metal carry bigger loads, resist harder wear, by specifying the correct alloy strengthened and toughened with Nickel.

**NICKEL** CAST IRONS

## HIGHWAYS



\*Reg. U. S. Pat. Off. by The International Nickel Company, Inc., Canadian Patent No. 281986

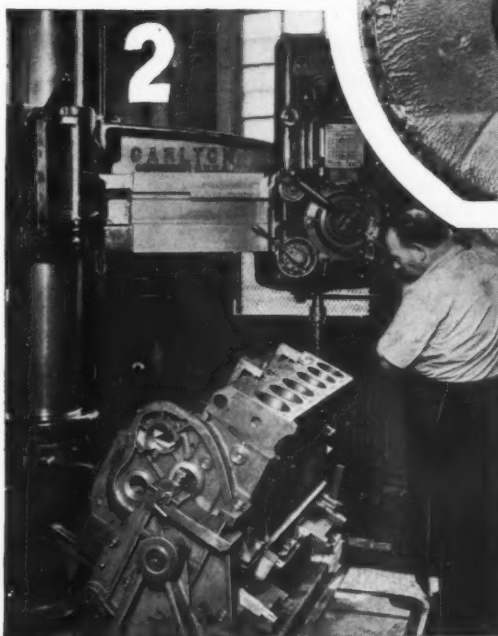
THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

General Motors' use of Nickel alloyed iron in Diesels for these Santa Fe streamliners cut weight per H.P. Nickel-chromium iron is tougher, retains strength at high temperatures, and wears longer.

## WATERWAYS



3



28-inch dredge liners used at Ft. Peck Dam. Under identical conditions the liner at left above, rolled from plain steel wore out after handling less than 1½ million cubic yards. The liner at right above cast from Ni-Hard®—the abrasion-resistant Nickel iron—withstood 2-1/3 million yards and after inspection it was put back in service to add millions more yards to its career.

Mack Mfg. Corp. casts these heavy duty truck cylinder blocks in their own foundry from Nickel alloyed iron. Nickel increases machinability, permits drilling at speeds 1½ times faster than in other irons of same hardness.

years with this company. In 1929 Mr. Whitaker joined the Hoover Co. where, as director of development and design, he had charge of engineering and was again closely associated with the patent department, all patent drawings and engineering patent co-ordination being carried out under his direction.

LOUIS M. GREENE has undertaken new duties in engineering supervision of both Pathe Engineering & Tool Mfg. Co., and its subsidiary, Multi-Needle Engineering Co.

DELMAR G. ROOS has been named vice president in charge of engineering of Willys-Overland Motors Inc., Toledo, O.

DR. PAUL L. SMITH has been reappointed for 1939 as research associate of the Porcelain Enamel institute. Associated with the National Bureau of Standards, Dr. Smith has been conducting technical research projects for the institute since his original appointment in 1937.

A. J. GILLESPIE has been appointed assistant chief engineer of Thew Shovel Co. Simultaneously with this and other appointments the engineering department has been moved from Cleveland to Lorain, O.

D. S. BRISBIN has been made president of Motor and Equipment Manufacturers' association. He is connected with Columbus-McKinnon Chain Corp. D. H. DASKAL, of Perfection Gear Co., was named vice president.

R. LEE HOMSHER, formerly sales engineer for Allis-Chalmers Mfg. Co., has been named designing engineer for Kimberly-Clark Corp., Neenah, Wis.

HAROLD H. STRAUS is now a member of the stress analysis department of the Northrop division of Douglas Aircraft Co., El Segundo, Calif.

JOHN L. V. BONNEY JR. has become associated with the technical division of E. I. du Pont de Nemours & Co. Inc. He was formerly connected with the observation corps of Carnegie-Illinois Steel Corp.

THOMAS R. MARTIN has transferred from Arthur G. McKee & Co., where he was equipment engineer, to Sawyer-Massey Ltd. as assistant chief engineer and assistant production manager.

PROF. ALFRED V. DEFOREST, of Massachusetts Institute of Technology, has received the 1938 Sylvanus

Albert Reed award for developing the "magnaflux" method of testing metals used in aircraft construction for flaws. The award was presented to Professor deForest at the annual honors dinner of the Institute of the Aeronautical Sciences.

PROF. FRANK B. ROWLEY was recently awarded the American Society of Heating and Ventilating Engineer's medal for "distinguished scientific achievement in heating, ventilating and air conditioning" at the annual meeting of the society. Professor Rowley is director of engineering experiment station of the University of Minnesota.

CHARLES B. BOHN was elected president of Aluminum association at its recent annual meeting. He is president of Bohn Aluminum & Brass Co.

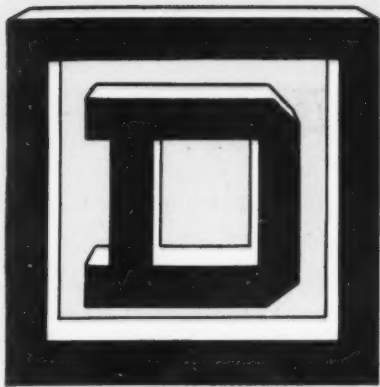
M. A. BELL has recently been made president of the Bell Machine Co. replacing the late E. J. BELL. Mr. Bell's practical engineering, sales and factory experience will be of assistance to him in his new position as president. He is a graduate of the University of Wisconsin and has been connected with the company for sixteen years.

PAUL O. PIPPEL, formerly assistant manager of the patent department of International Harvester Co., has been advanced to general patent attorney for the company. Mr. Pippel replaces V. F. LASSAGNE who has retired from active service. R. D. ACTON has been promoted to succeed Mr. Pippel.

DR. GEORGE W. LEWIS, director of research for the national advisory committee for aeronautics, Washington, has been elected president of the Institute of the Aeronautical Sciences, succeeding T. P. WRIGHT, director of engineering of Curtiss Wright Corp.

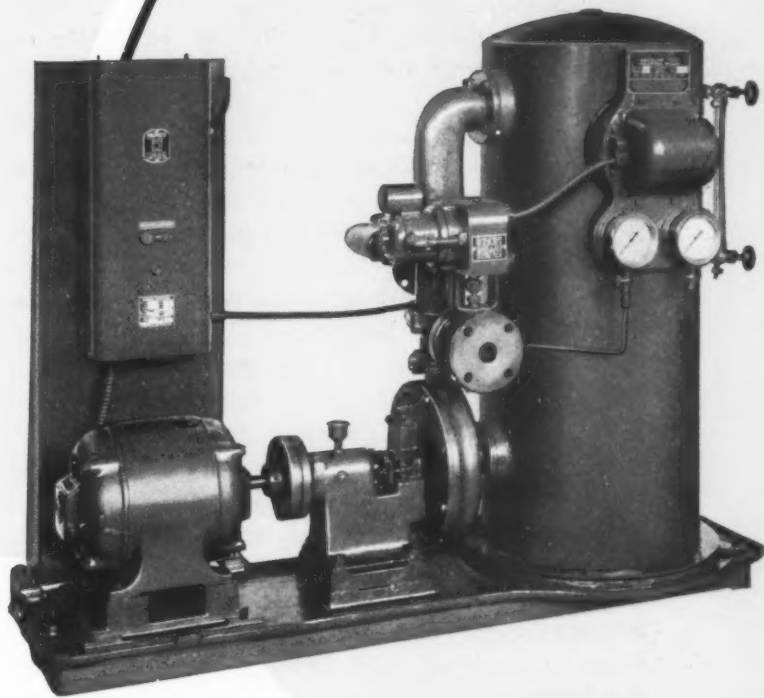
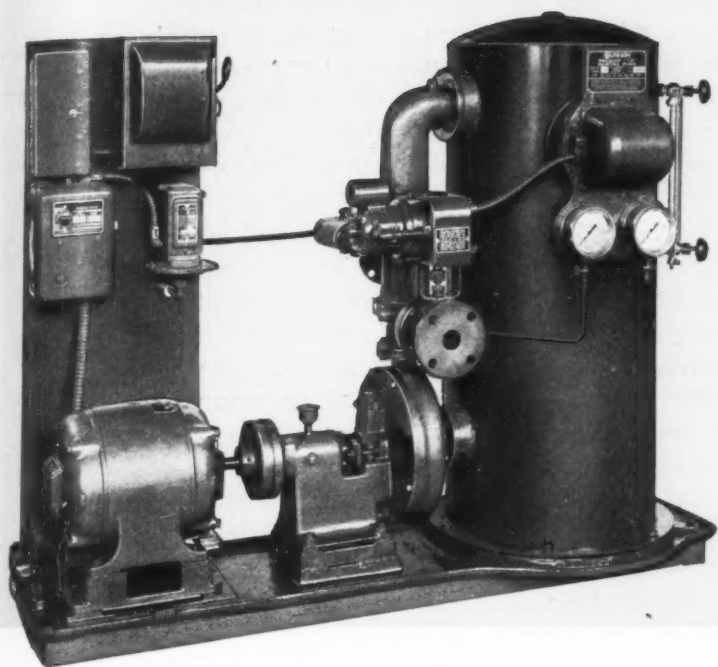
GEORGE F. WALES has resigned as chief engineer of the stamping plant of American Radiator Co., in which capacity he had been for the past fifteen years, to devote his entire time to the industrial product design and management of the Strippit Corp., Buffalo, of which he is president and founder.

F. L. PIERCE, formerly staff engineer of the Hoover Co., has been placed in charge of engineering, working closely with the patent department of the company. Mr. Pierce, a mechanical engineering graduate of the University of Michigan in 1926, has been with the Hoover Co. since that time, except for brief connections with General Motors and Asbestos Mfg. Co. He progressed through the laboratories to the head of the mechanical section, to staff engineer, and later senior staff engineer.



# Unified

## MOTOR CONTROL

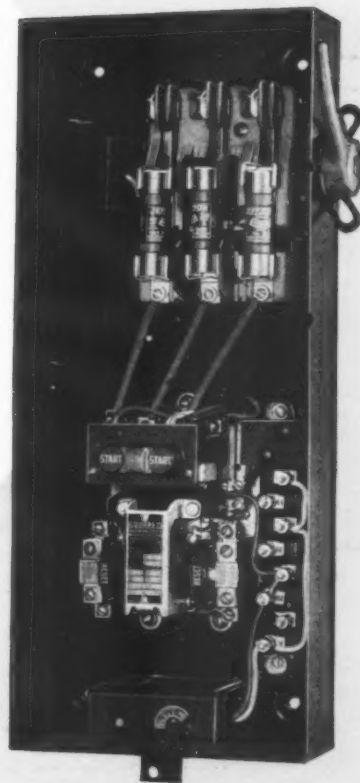


● The pictures present a striking "before and after" story. The former control for this vacuum pump consisted of a disconnect switch, a vacuum regulator, an automatic motor starter, and a terminal box—four units, of different manufacture, to be mounted separately and connected separately.

The new equipment is Square D Unified Control. Square D manufactures all of the required units and can mount them in a single enclosing cabinet. The advantages are obvious. A neater and more compact control assembly; all internal wiring done by the control manufacturer; no greater cost for the apparatus; lower cost for installation; and a guarantee of all units by the Square D Company.

Square D builds unified control for many applications. Switches and automatic starters in combination with pressure, vacuum and float switches and with temperature control.

You can improve the utility, economy and sales appeal of your equipment by changing to Square D Unified Control.



Square D Unified  
Motor Control

CALL IN A SQUARE D MAN

**SQUARE D COMPANY**

DETROIT - MILWAUKEE - LOS ANGELES

IN CANADA: SQUARE D COMPANY CANADA LIMITED, TORONTO, ONTARIO

# ASSETS *to a* BOOKCASE

## Engineers' Manual

*By Ralph G. Hudson; published by John Wiley & Sons, Inc., New York; available through MACHINE DESIGN for \$2.75 postpaid.*

This second edition of Hudson's Engineers' Manual contains revisions and extensions of all tables of physical constants, new steam tables, recomputations of conversion factors affected by the latest definition of the British thermal unit, an enlarged table of conversion factors and other useful additions throughout the book. Also, the entire chapter on heat and a large part of the chapter on electricity have been rewritten.

Useful to practising engineers, it presents in systematic order the definitions, symbology, constants, tables and formulas in such a way as to be quickly and accurately applied. Catchwords, symbols and formulas are printed in full face type. Problems are included to show applications of principles discussed.

Mathematics is summarized in the first section and includes definitions and derivations for the application of algebra, trigonometry, analytic geometry, calculus, differential equations, vectors and hyperbolic functions. The section on mechanics includes kinematics, relations of mass and space, kinetics, statics and properties of materials with tables for standard shapes and forms.

Hydraulics covers definitions and basic formulas for hydrostatics, hydrodynamics, weirs and jets. A chapter on heat discusses gases, liquids, vapors and their applications to air compressors, engines, and refrigeration. In the chapter on electricity are included magnetism; electrostatics; direct, transient, and alternating currents; and the principles of electrical machinery and power transmission.

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## Thermodynamics, Fluid Flow and Heat Transmission

*By Huber O. Croft, published by McGraw-Hill Book Co. Inc., New York; available through MACHINE DESIGN for \$3.50 postpaid.*

Fundamental information useful to practising engineers embraces thermodynamics, dimensional analysis, fluid flow and heat transmission treated as one continuous subject. Of particular interest in this book is the complete discussion of dimensionally correct and empirical equations. An entire chapter is devoted

to the theory of dimensional analysis, its uses in researches and its application to the derivation and testing of formulas.

Differential equations useful in energy equations, computations of vapor tables and other forms are discussed. Interrelations of solid-liquid-vapor phases of fluids are treated with the aid of charts and differential equations for several methods of approach. Computation of maximum available energy from the Carnot cycle is discussed as a measurement for efficiencies of practical cycles.

The same method of approach is used in calculating heat exchanger problems. Heat balance of internal combustion engines is also calculated in this way and compared with calculations using the first law of thermodynamics. The same approach is made for steam power plants, vapor cycles and steam turbines.

Friction losses in the flow of fluids are computed for various conditions of liquid flow and gases. Tables and charts show the variations in friction factors for pipes of different diameters and materials.

A chapter on heat transmissions includes radiation characteristics of various materials, liquids, gases and flames. Also conduction and convection are discussed with characteristics and formulas. Tables contain critical constants, average heat capacities, variations in viscosity of various liquids and gases for temperature changes.

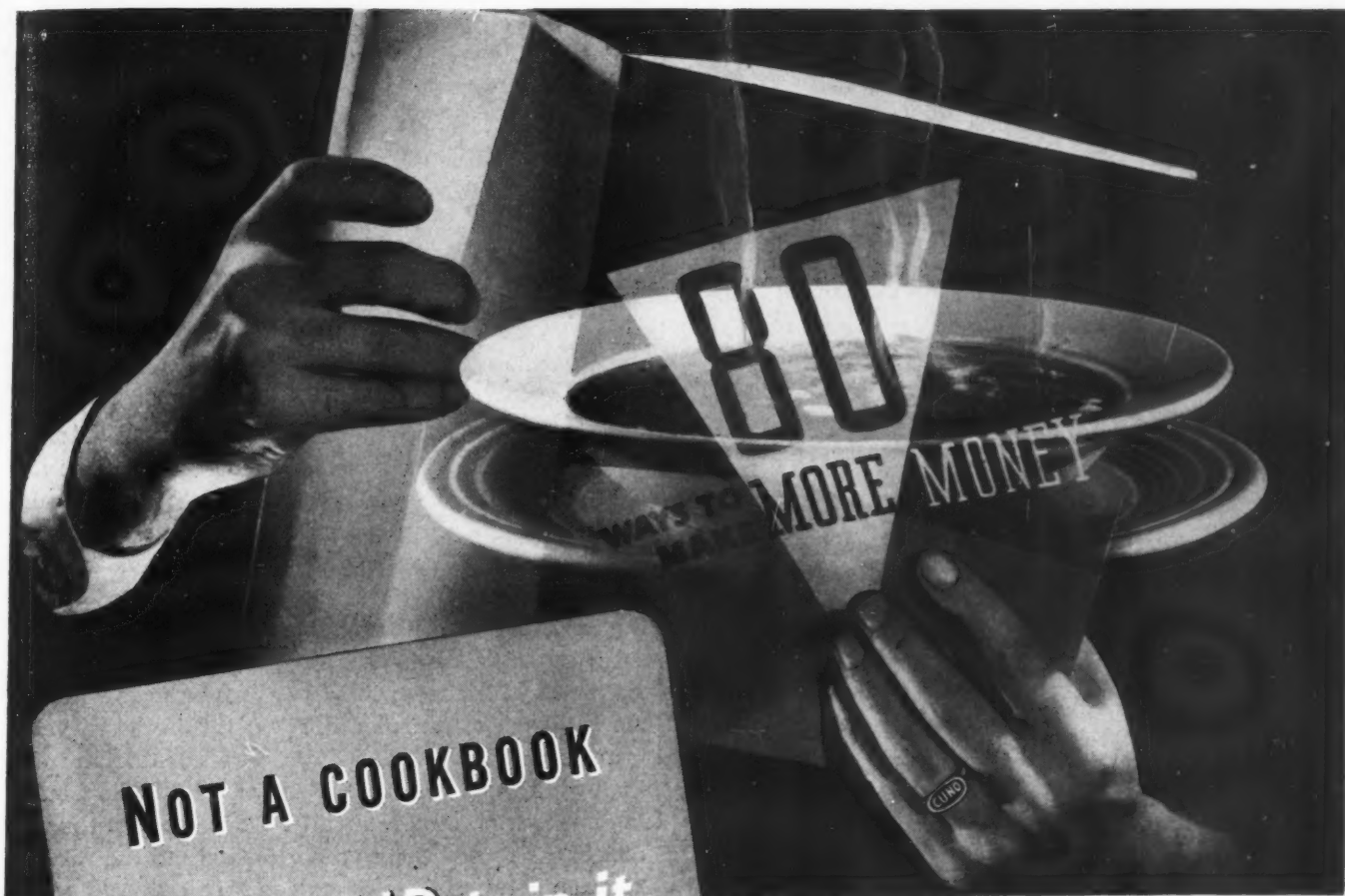
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## U. S. S. Carillo Steels

*Published by Carnegie Illinois Steel Corp., Pittsburgh and Chicago; available through MACHINE DESIGN for \$1.00 postpaid.*

Hardening of steel, based on practical and fundamental behaviors, discussed from recent findings. This handbook on alloy steels contains a list of steel making elements, their commercial uses, their effect in steel and the types of steel containing them. Analyses of S. A. E. alloy steels are included together with some of their commercial applications.

Chapters discuss the iron carbon diagram and its use for hardening and annealing operations, heating practice and heating furnaces for hardening and annealing, and quenching practice and the physical properties of different grades of alloy steels after quenching in various ways. The book is illustrated with many charts, some of which have not been published heretofore.



Here's a book that's so downright interesting, you'll take it home to read. It's the adventure of Cuno in your industry (and in many others) successfully adapting Cuno *continuously cleanable* filters to all kinds of jobs. Even soup.

Here's an epochal story of progress in engineering . . . of a new kind of filtering efficiency for you . . . of a new way for *you* to save money. Look over the 75 fluids Cuno is now straining . . . all the way from Acetone and Air to Water and Wax . . . and *continuously*. Old fashioned stop and go filtration is avoided. Think man, how you can use Cuno. The book is free. Use the coupon below.

IN EVERY industry where a fluid is used, including air and gases, Cuno *continuously cleanable* filters are making money. The well-known Cuno Auto-Klean, operating on the principle of edge filtration, permits positive mechanical cleaning of the filter element in one quick revolution — without interruption of the flow. Other members of the Cuno family, also continuously cleanable, are especially designed for the removal of extremely fine particles (as small as .001") and highly abrasive solids. Protection is continuous. No duplex installations. Nothing to do but install — and run. And they are made to your own private requirements. One or a thousand gallons an hour. Name your conditions.

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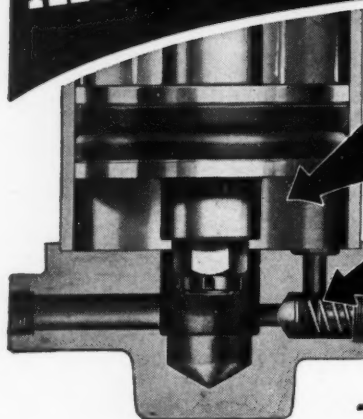
*avoid stop and go with* **CUNO** Filters

CUNO ENGINEERING CORPORATION



MERIDEN, CONNECTICUT

**NOW WRITE**  
*Cushioned* **IN ALL**  
**AIR CYLINDER "SPECS"**



New Non-Adjustable Air Cushion by NOPAK eliminates need for non-cushioned cylinders.

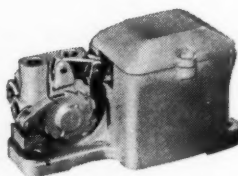
Quick-Opening Air Duct assures swift, smooth cylinder action on every stroke.

## — Give Your Machines New Smoothness

Instead of specifying "cushioned" or "non-cushioned" cylinders, simply specify NOPAK Cushioned Air Cylinders in one of these types:

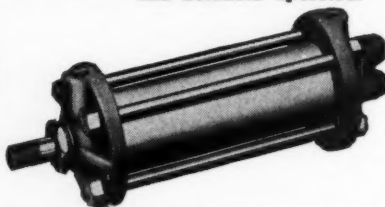
- New type NOPAK Cushioned Air Cylinders with Non-Adjustable Cushion-Heads. They eliminate the noisy, damaging metal-to-metal impact of non-cushioned cylinders . . . yet sell in the same price range.
- Standard type cushioned air cylinders with adjustable Cushion-Heads . . . where close regulation of "cushion effect" at end of piston stroke is required.

Either type assures smooth, efficient, trouble-free performance of air powered equipment, prolonged life for pistons and cup-leathers, lower maintenance cost for the entire cylinder assembly. Both types have Special Composition Cup Packing and extra-wide piston bearing to protect cups from excessive wear and friction. Write for bulletin.



For positive control, specify famous patented NOPAK Air Operating Valves . . . Lever, Foot and Solenoid operated.

NOPAK Non-Adjustable Cushioned Air Cylinder with Pendulum Mounting. Made in all Standard Mountings.



**GALLAND-HENNING MFG. CO.**  
2752 South 31st Street Milwaukee, Wisconsin

**NOPAK** VALVES  
and CYLINDERS

A 2490-1/2

## Noteworthy Patents

### Disk Brakes Are Self-Energizing

A RADICAL departure from conventional automobile brakes has been designed to provide relatively large braking areas together with self-energizing action. Vincent Bendix has assigned patent No. 2,140,731 covering this brake to Bendix Aviation Corp. In the brake, stresses are equalized within the assembly without any axial thrust.

On applying the brake, torque on the shaft with a universal joint shown in *Fig. 1* turns a gear which is meshed with an annular rack on the inside movable brake shoe. The outside shoe is prevented from turning by a key between its flange and the spindle mounting but is free to move axially. Cams between the two disk shoes spread them proportionately to the relative rotation between them to engage with the faces of the brake housing. This housing is integral with the wheel and transmits the braking action to it. Thus the cams are enabled to spread the disks axially to provide the required braking pressure.

The two faces and disk construction distribute the pressure more evenly and over greater areas than is possible in conventional designs. Leaf springs between the shoes keep the cams in engagement and the disks free when the brakes are not in operation.

Self-energizing action is provided after braking has been initiated by the friction drag between the shoe and housing. This drag, in the direction of wheel rotation, is in the same direction as the initiating action and tends to increase the cam action and braking force.

The brake disks are entirely enclosed within the

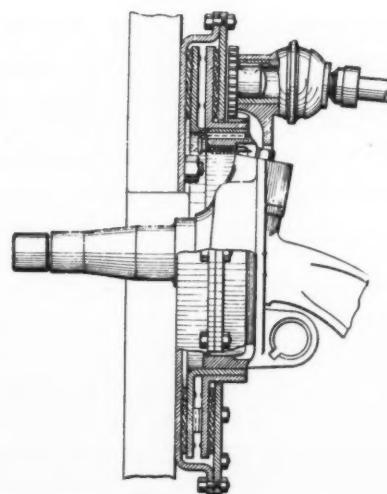
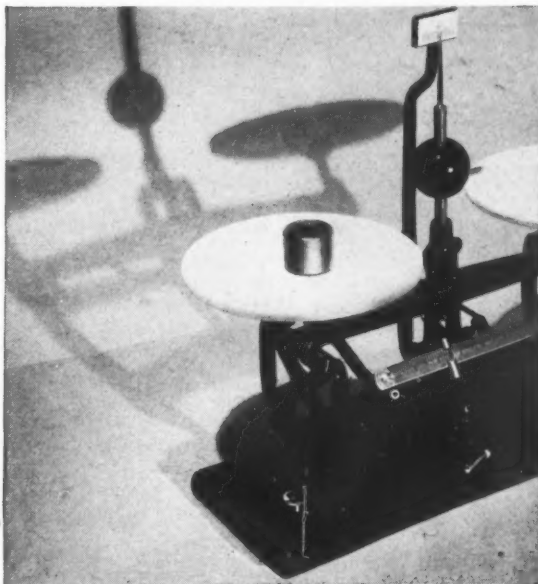
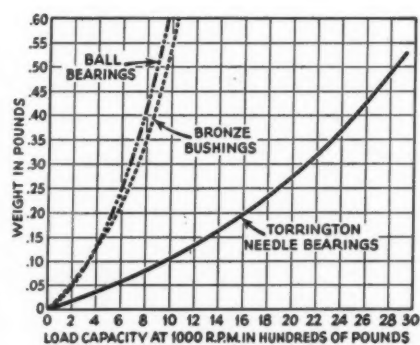


Fig. 1—Self-energizing disk brake distributes pressure evenly over large area

# COMPARE THE WEIGHT of the **TORRINGTON Needle Bearing**



**N**OTE from the accompanying graph the lighter weight of the Torrington Needle Bearing, compared with ball bearings and bronze bushings of the same radial load capacity. The values selected are typical; similar savings in weight are obtained at other speeds.



NOTE: Bronze Bushings to have same overall dimensions as Needle Bearings

Translate these savings in weight into terms of your finished product. When you consider that the use of Torrington

Needle Bearings may save many ounces on even as small a unit as a portable tool, you will appreciate the full importance of this single feature.

And note, too, that the lower weight of the Needle Bearing is only a part of the total saving in weight. Small in size and compact in design, the Needle Bearing helps you to reduce weight in other parts of your design as well, because it allows you to use a very simple form of housing.

#### Unit Cost is Low

You can obtain these weight-saving advantages at very low cost. The Needle Bearing itself is surprisingly inexpensive in proportion to its capacity. Assembly cost is low, too; the bearing can be quickly pressed into the housing with a minimum of labor.

The efficient operation of the Needle Bearing means customer satisfaction, for

it offers all the advantages of anti-friction construction and needs little service attention. The hardened retaining shell, with its turned-in lips, forms a reservoir to hold ample quantities of grease or oil. The rotation of the needles constantly supplies lubricant to the rotating shaft.

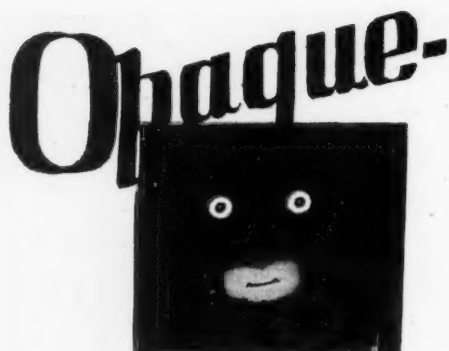
Consider the advantages of the Needle Bearing in your product. The Torrington Engineering Department will cooperate with you in laying out applications. For further information, write for Catalog No. 9. For Needle Bearings to be used in heavier service, request Booklet 103X from our associate, Bantam Bearings Corporation, South Bend, Ind.

*The Torrington Company*  
ESTABLISHED 1866  
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Makers of Ball and Needle Bearings

Branch Offices in all Principal Cities

## TORRINGTON NEEDLE BEARING



● For better blueprints—reproductions direct from the pencil drawings—you need a drawing pencil with lead that is **opaque** "as a darky in the dark," **uniform** "as the Grenadier Guards."

Mars LUMOGRAPH makes clearer and sharper blueprints than you have ever thought possible because it contains a secret light absorbing element combined with its finely ground lead.

Save your time and money with no sacrifice in quality by making your blueprints, "black and whites," red line or any other reproductions direct from your LUMOGRAPH drawings.



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Mars LUMOGRAPH brings you the result of 275 years of pencil making experience. Try a few and prove its superiority. 17 degrees—15c each—\$1.50 a dozen packed in a metal box. If your dealer cannot supply you, send us your order and his name.

#1018 Artist (Chuck) Pencils  
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TRADITION CHROMA  
Colored Pencils  
Strong—Brilliant  
Made in 16 Special Colors



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**LUMOGRAPH**

casing which excludes foreign matter that might be detrimental to the proper functioning of the brake. Adjustment for wear is readily made by advancing the gear rack with respect to the gear.

### Propeller Design Dampens Vibration

**A**IRPLANE propellers driven from the center of percussion of each blade have been designed by Erle Martin. Assigned to United Aircraft Corp. and covered by patent 2,144,428 this propeller will not vibrate in resonance with the vibration frequency of the engine. Thus fatigue stresses are greatly reduced allowing for lighter and more durable blades.

In this design, the blades travel radially without any whip. As a result they are more efficient in op-

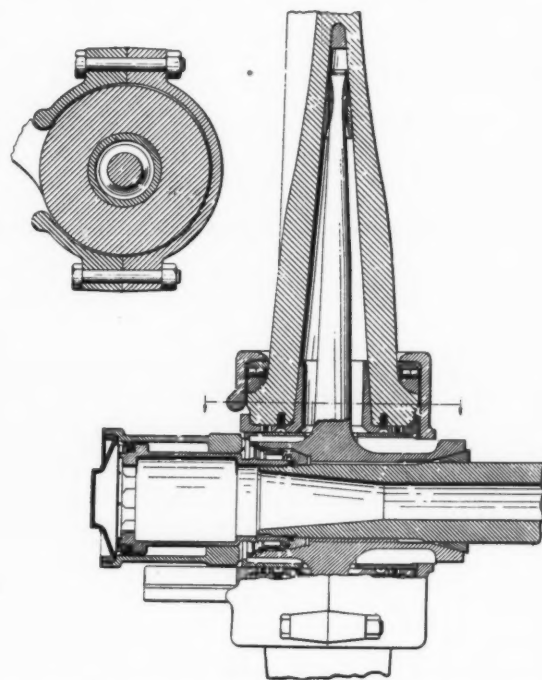


Fig. 2—Spider drives airplane propeller from center of percussion of blade

eration. The blades are hollow (Fig. 2) with spider arms mounted integrally with the drive shaft and extending into the blades. At the center of percussion of each blade is a bearing through which the power is transmitted.

The base of the blade is mounted between antifriction bearings and rubber pads to provide a limited freedom between the propeller blade and spider. If the propeller should be slightly out of balance the resilience of the pad allows the parts to seek balanced position. In addition, this cushioned mounting tends to absorb any vibrational effects of the drive shaft. The properties of the pads are chosen so that the natural period of the propeller is below the rotational speed of the shaft. Likewise, the flexibility of the spider arm is adjusted to bring the period of the rotating mass below the frequency of vibrational effects in other directions.

Pitch of the blades is controlled by the hydraulic

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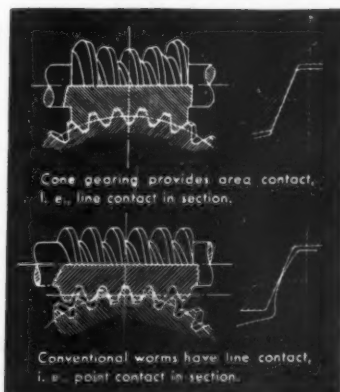


# 5\* TIMES *The* LOAD *with* CONE WORM GEARING

Five times the usual rating for worm gearing is what Cone Worms are called upon to transmit, day in and day out, in Halliburton's new portable 6,000 lb. pressure cement pumps in the oil fields. To make such pumps possible, the worm gear drive, delivering 110 hp. from the truck engine to the pump at 200 rpm. of the worm had to be held small enough and light enough to make the unit mountable on a truck.

The diagram above shows the comparison between the Cone gears used by Halliburton and the size that would have been required based on usual worm gear ratings.

The reason compact Cone gearing can carry higher loads is AREA CONTACT.



**CURRENT CONE OPERATING RANGES**  
Ratios.....Low, 1 to 6; High, 150 to 1  
Speed...Low, 1/15 rpm.; High, 30,000 rpm.  
Sizes (C.D.) Low, 5/8 in.; High, 27 1/2 in.

Cone worms and wheels are generated in such a manner that there is in continuous contact the entire depth and a substantial portion of the width of each worm and wheel tooth in engagement—and there are more teeth in engagement.

Further, lubrication is no problem with Cone gearing. Oil is 'pumped' through the contacting surfaces instead of being scraped off.

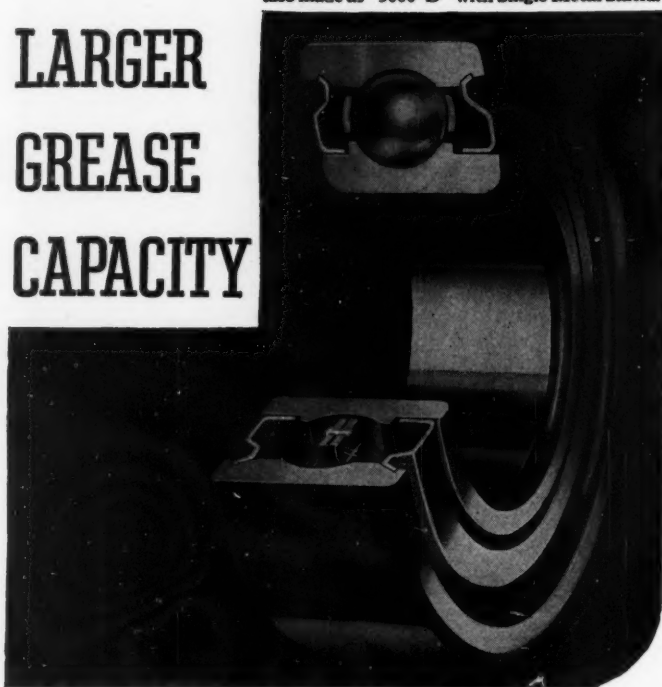
And finally, both worm and worm wheel tend to re-generate the original form. That is why Cone wheels and worms wear IN instead of OUT.

\*Ordinarily Cone gearing is sold on a basis of about four times the usual mechanical rating for worm gears.

**MICHIGAN TOOL COMPANY, 7171 E. McNICHOLS RD., DETROIT, MICHIGAN**

"9000-DD", with double Metal Seals, here shown;  
also made as "9000-D" with Single Metal Shield.

**LARGER  
GREASE  
CAPACITY**



## **NO SEAL DRAG**

IN "9000" SERIES (Feltless)

## **SELF-SEALED BEARINGS**

Interchangeable in dimensions with felt seal bearings.

Employs simplified, inwardly extending, flanged metal shields which do not rotate and cannot "foul" other rotating seal parts.

Seals are highly efficient in retaining grease in either horizontal or vertical position.

Simple seal occupies less space within bearing than felt seal, PROVIDING GREATER GREASE CAPACITY AND A MORE LASTING LUBRICANT SUPPLY.

Metal seals, though close fitting, clear recess on inner ring, ELIMINATING "DRAG" OR FRICTIONAL RESISTANCE and power loss, and providing higher starting speeds and increased efficiency. Seals cannot wear and are permanently effective.

Totally sealed against foreign matter, providing absolute cleanliness at all times.

**"NORMA-HOFFMANN"**

**PRECISION BEARINGS**

BALL, ROLLER AND THRUST

**NORMA-HOFFMANN BEARINGS CORP'N.**

**STAMFORD, CONNECTICUT, U. S. A.**

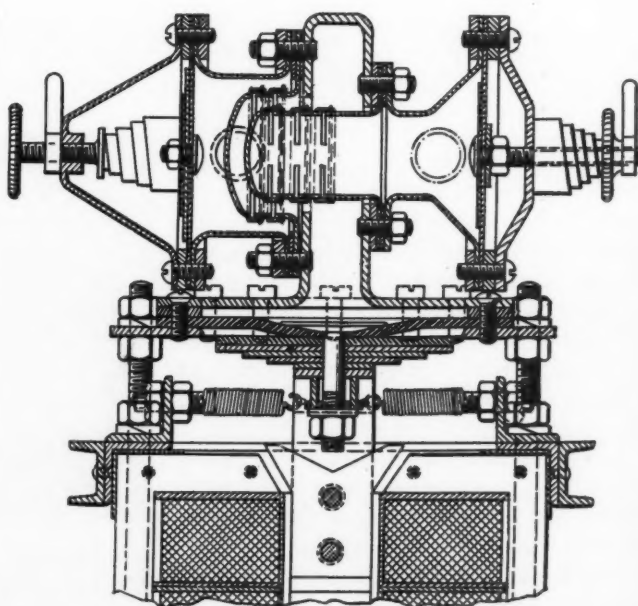
chamber shown at the left side of the hub. This chamber is operated through the hollow drive shaft. Below the chamber is a counterweighted arm on the blade, the centrifugal force of which tends to turn the blades to high pitch. Such an arm on each blade is connected to the piston so that its action may be regulated by the pressure in the hydraulic piston. The insert shows a section through the base of a blade and the arm for adjusting the pitch by blade rotation to the desired position.

## **Fluid Pump Employs Electromagnet**

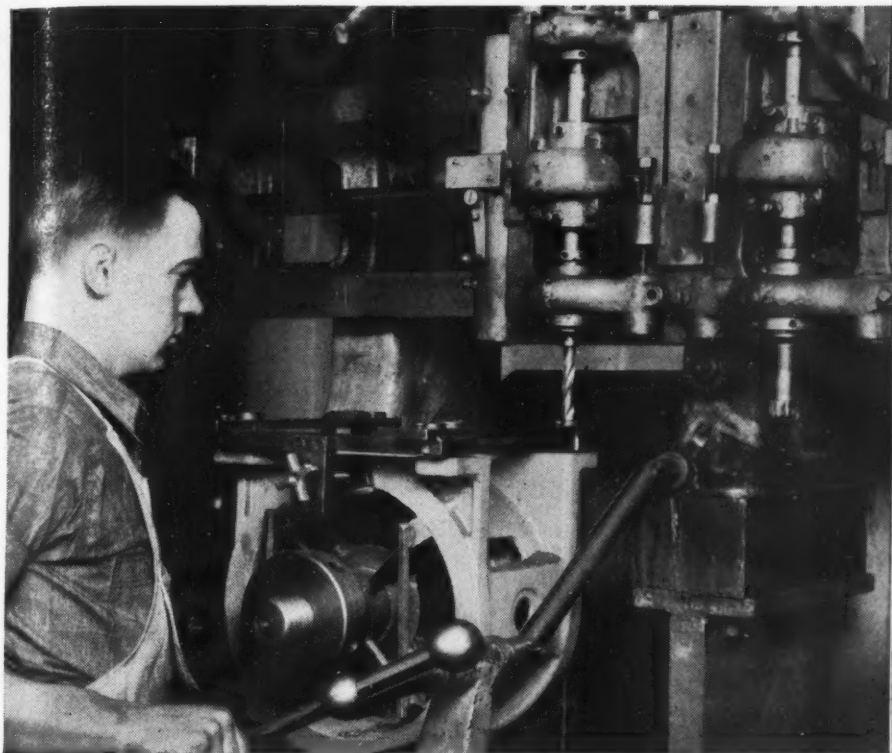
**A**DVANTAGEOUSLY employing vibrating diaphragms in suction, working and pressure chambers, the electric fluid pump shown in *Fig. 3* automatically adjusts itself to throttling of fluid delivery. Designed by Georg Szekely, Germany, this invention is covered by patent 2,143,391.

Driving power is supplied by an electromagnet in the base. The core vibrates at the frequency of the alternating current supply. An adjustable spring of the same frequency at the bottom of the unit (not shown but similar to one on the pressure chamber) tends to return the core to a central position. At the other end of the core is connected a pulsating diaphragm which transmits the working effort to the fluid. This core is held central and the air gap kept constant by horizontally mounted springs above and below the electromagnet.

Above the working chamber are the suction and pressure chambers. Each contains a diaphragm with a vibrating period in resonance with the system and adjustable compression and extension springs respectively. This compensates for pulsing of the pump and



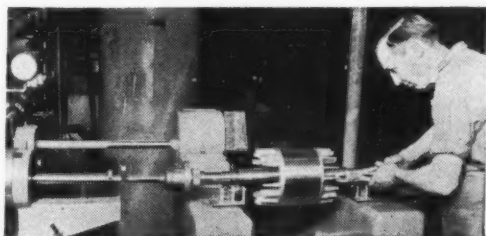
*Fig. 3—Electromagnet vibrates diaphragm in pump according to requirements*



## MILLED AND DRILLED to give you better alignment

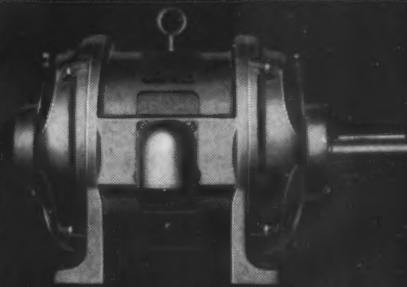
There is one characteristic of every step in the making of a Delco motor: As many operations as possible are done with one set-up, to insure absolute accuracy; and each machined surface is registered with every other machined surface.

Most operations are done on special machines, designed and built for the particular job, so that absolute uniformity of manufacture is maintained. For example, the rough main frame of a Delco motor is chucked through the stator opening; all four feet are milled to the same height, and in the same place; and the mounting holes are drilled—all in one set-up. This precision is typical of every operation at Delco Products. That is why we ask you to look *within* the motor you specify.

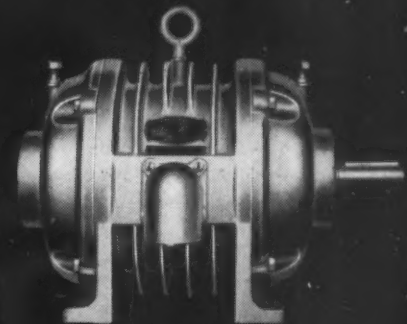


### EVERY DELCO MOTOR IS DYNAMICALLY BALANCED

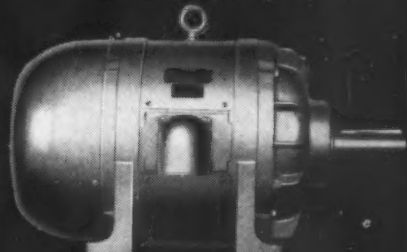
No motor leaves Delco Products that has not been dynamically balanced on a specially-designed balancing machine. Delco balances every motor. Each end of the rotor and shaft is first balanced independently, while the machine indicates exactly how much compensation is required and where it should be applied. After all adjustments have been made, the complete rotating assembly is given a final check. Delco motors assure satisfactory balance.



Open Frame, Sleeve or Ball Bearing



Totally Enclosed Ball Bearing



Totally Enclosed Fan-Cooled Ball Bearing



Fractional Horsepower Motor

Delco industrial AC motors are available in various types, possessing electrical and mechanical characteristics to meet practically every requirement.

Normal starting torque—normal starting current—high starting torque—low starting current—as well as high slip. Each type available in open frame, sleeve or ball bearing—totally enclosed ball bearing—totally enclosed fan-cooled ball bearing—also multi-speed motors. Electrical and mechanical modifications available. Delco motors comply with NEMA standards.

# DELCO

DIVISION OF GENERAL

DELCO  
PRODUCTS  
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DAYTON  
OHIO

# MOTORS

MOTORS CORPORATION

**Mechanics, too, appreciate the  
Beauty and Serviceability of..**

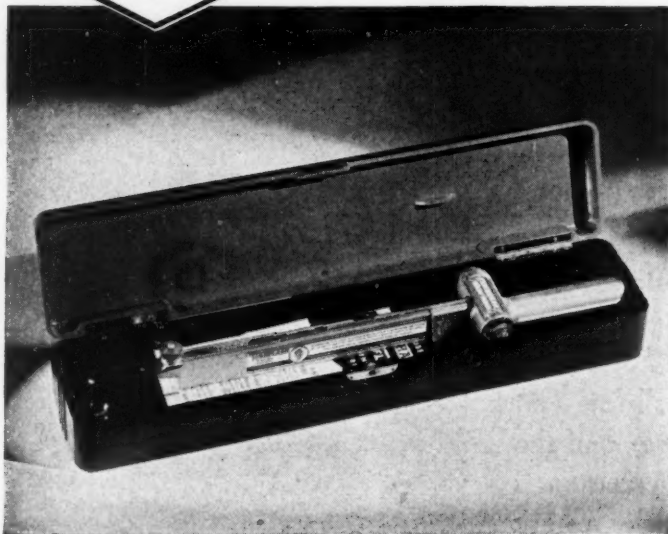
## Eclipse Moulded PLASTICS . . .

As a fitting companion for their sensational new "Torkflash" Tension Wrench, Blackhawk Manufacturing Company designers wisely chose a modern Eclipse Moulded Tool Box of Bakelite. The attractive, lustrous black box with its rich red cover is not only an additional merchandising help to Blackhawk, but is one of the many difficult and intricate jobs Eclipse designers and craftsmen do so well.

**Eclipse**  
MOULDED  
**TORKFLASH**  
TOOL BOX  
Moulded for  
**BLACKHAWK**  
MFG. CO.  
Milwaukee

Practically every manufacturer can use parts of plastic to improve the saleability of his product. But it requires the proper plastic for your problem.

Send us your blueprints today for quotation.



**MOULDED PRODUCTS COMPANY**  
**MILWAUKEE WISCONSIN**  
Chicago : Detroit : St. Louis

• Moulders of . . .  
Bakelite, Durez, Resinox, Plaston, Tenite, Beetle, Etc.

Call upon Eclipse for an UNBIASED recommendation.

Eclipse Designers, Engineers, Craftsmen are trained in moulding ALL PLASTICS. They know which of the many available modern plastic materials will most profitably serve your needs. Send blueprints or write for salesman to call.

serves the same capacity as compressed air cushions in other forms of pumps.

Fluid entering the suction chamber at the right passes to the working chamber through one-direction valve flaps shown on the inside dome. The pressure stroke or pulse forces the liquid through similar valves on the larger dome into the pressure or delivery chamber. Thus continuous flow is effected through the pump chambers.

Desired flow of fluid is controlled by a throttling valve. Restricted flow increases the pressure on the diaphragm causing the electromagnet to use a correspondingly lower amount of current. Complete throttling extends the diaphragm in the pressure chamber to its limit and then the working diaphragm. At this point, the armature core is at its lowermost position and the electromagnet will have the effect of a choke coil of high inductive resistance. The only current used then is the electrical loss. Therefore it is not necessary to disconnect the power supply when the throttle valve is closed for short periods of time, the exhaust valve closed.

phere.

## Design of Disk Springs

(Concluded from Page 37)

.271 and  $K = .696$ . Then from Equations (11) and (12)

$$S = K \frac{P}{t_i^2} = \frac{.696 \times 90,000}{(.75)^2} = 111,000 \text{ pound per square inch}$$

$$\delta = C \frac{P r_o^2}{E t_i^3} = \frac{.271 \times 90,000 \times (9)^2}{30 \times 10^6 \times (.75)^3} = .157 \text{ inch}$$

These values should be corrected because in the actual design the point of load application is  $\frac{1}{8}$  inch inside the edge as indicated in Fig. 13. Thus the distance  $d = 2\frac{3}{4}$  inches and  $r_o - r_i = 3$  inches. The corrected value of stress will be  $110,000 \times 2.75/3 = 101,000$  pounds per square inch and the deflection at the points of application of the load will be  $.157 \times (2.75/3)^2 = .132$  inch.

Since these deflections are much smaller than half the thickness it may be expected that the load-deflection characteristic of this spring will be approximately linear, being modified only by friction along the edges. By supporting the spring at the neutral axis with a stepped edge, see Fig. 4, this friction may be greatly reduced.

By using the formulas and charts given in this paper, the design of Belleville springs to obtain specified non-linear load-deflection characteristics becomes a relatively simple matter. Similarly, radially tapered disk springs may easily be calculated. The use of these types of springs has proved advantageous in many design applications.

**"Help Yourself"  
BEARINGS**



**A**LL you have to do whenever you want bearings is to help yourself from Bunting's big stocks. Completely machined and finished—ready for assembly—these "help yourself" bearings are available in hundreds of sizes for all mechanical applications and for electric motors of all makes from 1/50 hp to 100 hp. Write for catalog of these ready-to-use bearings, Bunting Precision Bronze Bars—machined I. D., O. D. and ends—and other Bunting products... The Bunting Brass & Bronze Company, Toledo, Ohio. Warehouses in All Principal Cities.



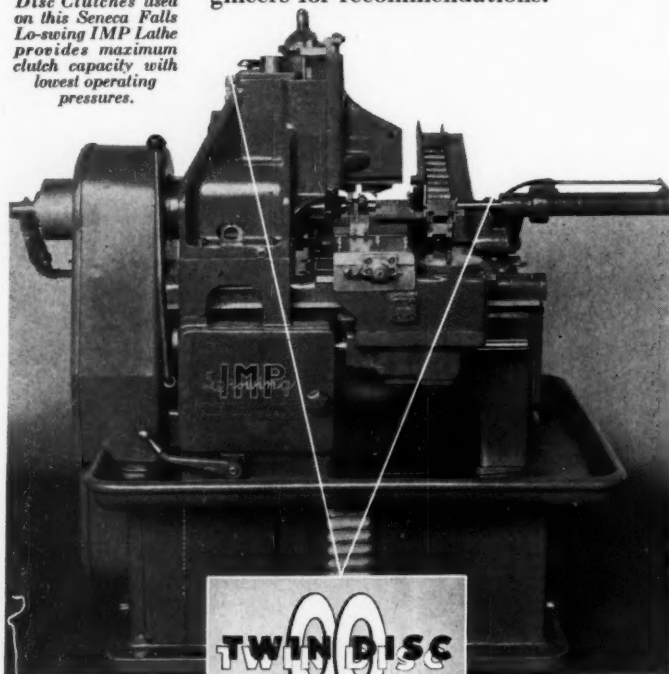
**BUNTING**  **Quality**  
**BRONZE BUSHINGS • BEARINGS**  
**PRECISION BRONZE BARS**  
**BABBITT METALS**

**Clutch Reverses  
Every 10 Seconds...**

**A Twin Disc of Course!**

The machine cycle of this IMP Lathe is very short . . . the lathe's motor runs continuously. That's why a Twin Disc Simplex Oil-Type Clutch is used on the main drive—and a Twin Disc Duplex Oil-Type Clutch as the rapid reverse. The latter clutch functions every 10 seconds. ¶ Being built for the job—not merely to fit a machine—Twin Disc Clutches can always be relied upon to contribute to—not impair—a machine's excellence of performance. That's why they are standard equipment on so many quality-built machine tools. Write Twin Disc engineers for recommendations.

*Single-point adjustment on the Twin Disc Clutches used on this Seneca Falls Lo-swing IMP Lathe provides maximum clutch capacity with lowest operating pressures.*



**TWIN DISC CLUTCH CO. • 1325 RACINE ST. • RACINE, WIS.**

## NEW Materials and Parts

(For Engineering Department Equipment see Pages 75, 76)

### Torque Motor Brake Announced

A NEW torque motor brake for alternating current service on elevators, cranes, hoists, and similar installations is announced by Cutler-Hammer Inc., 328 North Twelfth street, Milwaukee. This new brake is designed especially for those applications requiring positive, quick "cushioned" braking. A sturdy torque motor, operating through a simple, antifriction ball jack, releases the brake. The motor is stalled across the line when the brake is fully

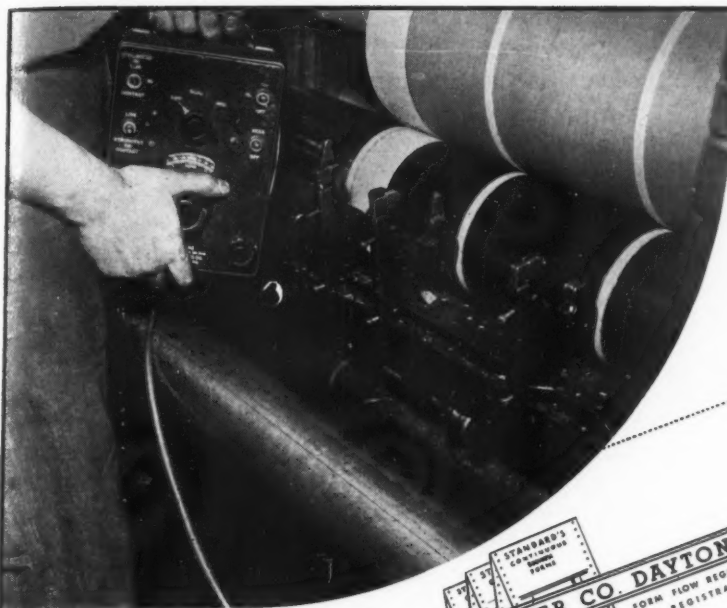
*For alternating current service on elevators, cranes and hoists, torque motor brake provides positive, "cushioned" braking*



released. When the circuit is opened, the heavy helical torque spring sets the brake, and a slight flywheel action of the rotor provides smooth braking. Large lining area results in low unit pressure and longer lining life. Shoes are adjusted individually to compensate for wear, and torque is also adjustable. Five sizes of the new brake are available, providing maximum torque ratings of 160, 400, 800, 1600 and 3200 pound-feet on intermittent duty. Continuous duty ratings are slightly lower.

### Treatment Aids Zinc Finishing

MAAS & WALDSTEIN CO., 438 Riverside avenue, Newark, N. J., has developed a new method of treating the surfaces of zinc, zinc-coated and galvanized products before finishing them with lacquer, enamel, paint or varnish. The new treatment



## QUALITY INSPECTION

**T**HE marginal punches on the continuous business forms manufactured for both machine and hand written records by The Standard Register Company have to be attractively and accurately printed. To inspect, for quality, the operations on their continuous carbon paper . . . while it is being punched, perforated and cut into strips as it goes through a special machine . . . **Standard Register uses five General Radio STROBOTACS.**

Simple to operate . . . portable . . . light-weight . . . having a speed stopping capacity from 600 to 100,000 rpm . . . the new Type 631-B STROBOTAC can be equally as effective in your manufacturing processes as it has been for Standard Register and for hundreds of other manufacturers. The STROBOTAC not only stops motion so that you can see movement in the most complicated machine frozen to a standstill, but it also permits viewing any machine in operation in exaggeratedly s-l-o-w motion . . . as slow as a fraction of an rpm.

If you have any problem, which requires seeing how your mechanical equipment operates, let us show you how the STROBOTAC can help you.

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GENERAL RADIO CO., Cambridge, Mass.

TYPE 631-B \$95.00

# High Efficiency Hydraulic Power

## FOR MODERN MACHINE TOOLS

Hydraulic power advantages are made more practical, easier to secure, through the new patented construction of Hannifin high pressure hydraulic cylinders. This exclusive construction is stronger, simpler, presents a better appearance, and is easily applied to a wide variety of uses. High efficiency hydraulic power is assured, with extra ruggedness to withstand severe service.

**NO TIE RODS.** This simpler design is stronger and eliminates a source of leakage. End caps may be removed without collapse of other parts of the assembly.

**UNIVERSAL CAPS.** Either end cap may be positioned independently, so that inlet port is at top, bottom, or either side. Either cap may be moved without disturbing the cylinder mounting or other parts.

**AIR VENT PLUGS.** Each end cap has air vents on three sides. With the inlet port at either side or bottom, there is always an air vent plug at the top.

**LEAK-PROOF.** Special mirror finish honing produces a cylinder bore that is straight, round, perfectly smooth, and concentric with the end caps. A perfect piston seal is obtained.

**MANY TYPES AND SIZES.** Available in six standard mounting types, with small diameter piston rod, 2 to 1 differential piston rod, or double end piston rod, in all sizes, for working pressures up to 1000 and 1500 lbs./sq. in. Furnished with or without cushion. Other types built to order, in any size, for any pressure.



### HANNIFIN MANUFACTURING COMPANY

621-631 South Kolmar Avenue, Chicago, Illinois

Engineers • Designers • Manufacturers

Pneumatic and Hydraulic Production Tool Equipment

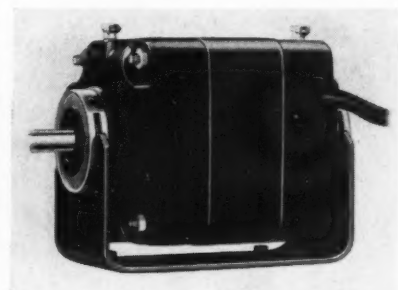
## HANNIFIN HYDRAULIC CYLINDERS

eliminates the difficulty often encountered in coating zinc with organic finishes, unless the finish is selected with great care, when the oxidation products of zinc combine chemically with the constituents of many finishes and thus destroy them. Pre-treatment by M&W involves dipping zinc or zinc-coated products in a solution of a compound called Zinsol, which causes the formation of an alloy, zinc and another metal, on the surface. This alloy is chemically inert to moisture and organic finishes generally, so that it forms a stable foundation for any desired kind of finish.

### Two Windings Possible on Small Motor

**O**HIO ELECTRIC MFG. CO., 5911 Maurice avenue, Cleveland, has announced a square fractional horsepower motor which may be wound for shaded-pole operation in sizes from 1/200 to 1/80-horsepower, and for permanent split capacitor operation in sizes from 1/150 to 1/20-horsepower at 3400 revolutions per minute; to 1/30-horsepower at 1700 revolutions per minute; to 1/50-horsepower at 850 revolutions per minute. Measuring 3 3/4-inch square by

*Fractional horsepower motor may be wound for shaded pole or permanent split capacitor operation in various sizes*



4 3/4-inch long plus a 3/8-inch diameter shaft whose standard length is 1 1/4-inch, it can be supplied to mount in any desired position or with resilient base as illustrated. When wound for permanent split capacitor operation, the motor's efficiency is practically double that of the shaded pole motor. The small capacitor may be mounted separately or on the motor. Starting torque is slightly above full load and maximum running torque is about four times full load.

### Hydraulics Provide Accuracy

**A**CCURACY of control, to a minimum of 5 cubic inches per minute, is provided in a new, small variable volume hydraulic pump announced by the Denison Engineering Co., 236 North Water street, Columbus, O. Although originally designed to accommodate the lower pump capacities, the pump is said to be suitable for almost any job where slow, accurately controlled high pressure is required. A rapid traverse or quick take-up permits the pump to deliver its maximum volume when it is not work-



## You can vary Hele-Shaw Fluid Power

*Quicker*

than a woman can  
change her mind

Hele-Shaw Fluid Power is oil under pressure. It provides instant and precise control. You can change its direction and vary its speed or pressure from zero to maximum, g-r-a-d-u-a-l-l-y or *instantly*—yes, quicker than a woman can change her mind.

This is *one* reason why so many machine designers, builders, and buyers are specifying Hele-Shaw Fluid Power for obtaining *controlled* linear or rotary motion. But there are other equally important advantages. Hele-Shaw Fluid Power offers wide flexibility of location. It increases production by instant and automatic adjustment to operating conditions. It sustains its pressures with a minimum loss of energy.

Write us for complete details. Ask us to show you how Hele-Shaw Fluid Power can be applied to advantage to the machinery you design, build or buy. Specify Hele-Shaw.

**A-E-CO**  
**HELE-SHAW**  
**FLUID**  
**POWER**



OTHER A-E-CO PRODUCTS: Lo-Hed Hoists, Taylor Stoker Units, Marine Deck Auxiliaries.

**A-E-CO**  
**Hele-Shaw**  
**FLUID**  
**POWER**

**AMERICAN ENGINEERING COMPANY**

2502 ARAMINGO AVENUE, PHILADELPHIA, PA.

# FARVAL

## Prevents Losses Due to Faulty Lubrication



*The positive piston-displacement Farval Valve, used to control the delivery of lubricant at each bearing, has but 2 moving parts and is extremely simple in operation.*

• Since the production machines you build are your customers' first-line source of profit, any interruption to operation cuts directly into your earnings. One of the most frequent and costly of *all* interruptions—bearing troubles due to lack of lubrication—*can be avoided.*

Farval Centralized Systems of Lubrication *prevent* losses caused by faulty lubrication of bearings, by delivering the lubricant, in exact measured quantities, at proper intervals, to every bearing—missing none.

Furthermore, Farval *increases* earning capacity by reducing power consumption; eliminating labor of oiling by

hand; saving lubricant; reducing repair bills; and by prolonging the life of machines.

Help your customers to maintain top production—install Farval and keep bearings fit. The Farval Corporation, 3265 East 80th Street, Cleveland, Ohio.



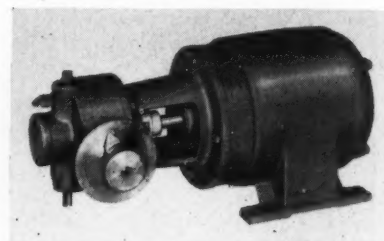
Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing.

# FARVAL

CENTRALIZED SYSTEMS OF LUBRICATION

ing against the load or against a light predetermined load. By means of an adjustment in the barrel the predetermined load can be established by setting the pressure at which the pump will stop delivering maximum volume and deliver the volume indicated on the control dial. This same control can be arranged to serve as an overload feature which will move the pump to no stroke, maintaining pressure but not delivering volume. The three-piston cylinder body

*Small variable volume hydraulic pump gives accuracy of control to a minimum of 5 cubic inches per minute*



and rotary valve are combined in a single shaft. Shaft and rotary are of heat treated tool steel, supported in one roller bearing and one ball bearing; the valve plate is of hydraulic bronze especially developed for the purpose. Two maximum volume capacities—100 cubic inches and 175 cubic inches—are offered in the same body size. This pump is said to be good for continuous operation at 1000 pounds per square inch and for intermittent operation at 2000 pounds per square inch.

### Formulate New Asbestos-Filled Plastic

TWO newly formulated, asbestos-filled Durez molding materials, known as Durez 38-443 and Durez 38-646, have been made commercially available by General Plastics Inc., North Tonawanda, N. Y. Durez 38-443 will withstand 490 degrees Fahr., has an impact strength of .23 and a compressive strength of 28,000. Specific gravity is 1.80. Durez 38-646 has an exceptionally low specific gravity for asbestos-filled molding compounds—1.59. Its heat resistance is 500 degrees Fahr., impact strength, .19, compressive strength 28,000. Its flexural strength, 9000, is high.

### Light Relay Uses Photoelectric Cell

THE Light relay, or Light switch announced by Electronic Products Corp., 2667 East Grand boulevard, Detroit, has many uses where the frictionless interception of a beam of light is to close or open an electrical circuit to initiate desired actuation. Using a conventional missive type photoelectric cell, feeding one stage of amplification, the relay is very compact, measuring only 6 inches long, 4½ inches high, 3¼ inches wide. The amplifier is a standard radio tube whose output operates a telephone type relay, contacts of which are rated at 75 watts, ar-

# MOVING MOUNTAINS *or* METERING POSTAGE

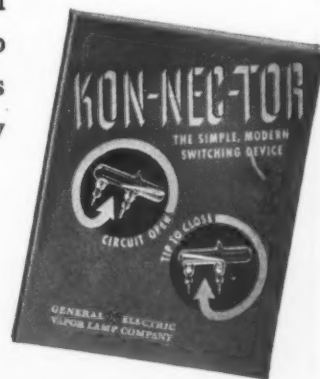


## KON-NEC-TORS Supply Unfailing Control

A mighty shovel for moving mountains and a high-speed machine for metering postage... they are alike in their demands on an electrical circuit with positive unfailing control. In machines of all kinds throughout industry KON-NEC-TOR Mercury Switches are still first choice. They are wear-proof and trouble-free, easily adapted to the design requirements of electrical equipment of all kinds. A clean make and break is always there. Corrosive fumes and

moisture cannot harm these switches, ever. » » » Whatever your needs, there's a KON-NEC-TOR of the right type and capacity. Write for a copy of the KON-NEC-TOR Bulletin No. 603. It gives complete specifications and available engineering suggestions. General Electric Vapor Lamp Company, 825 Adams Street, Hoboken, New Jersey.

**GENERAL  ELECTRIC  
VAPOR LAMP COMPANY**





Model  
No. 11020A

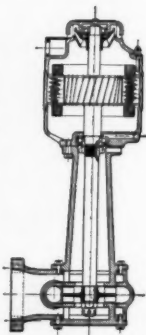
## THE GUSHER COOLANT PUMP

### A PRECISION BUILT COOLANT PUMP

NO UNSIGHTLY  
EXTERNAL PIPING

QUIET

A pump of increased efficiency that is easily mounted, hydrostatically balanced, self-cleaning and fully equipped with ball bearings. Split-second volume control. Designed to handle materials that contain grit and abrasives.



Write for Engineering Specifications Model No. 11022  
Patented and  
Patents Pending

**THE RUTHMAN MACHINERY CO.**  
540 E. FRONT ST. CINCINNATI, OHIO

## Now KOH-I-NOOR Drawing Pencils

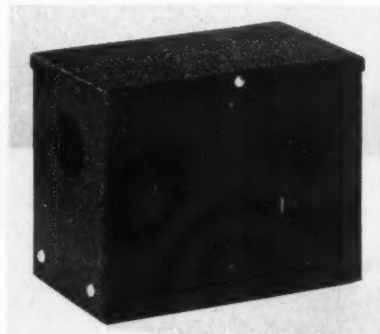
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10¢ each  
\$1.00 the dozen

Send for our latest catalog M-4

**KOH-I-NOOR PENCIL COMPANY, Inc.**  
373 Fourth Avenue New York, N. Y.

ranged for both a make and break circuit. A five-point terminal strip allows quick connection to the 115-volt, 50 or 60-cycle, or 110-volt direct current lighting line. The three other terminals are used for connection to the contacts of the magnetic

Conventional mis-  
sive type photoelec-  
tric cell is used in  
the Light relay to  
close or open cir-  
cuits



switch. A potentiometer with a screwdriver slot provides for sensitivity adjustment so that various light levels may be used. The beam of light between the light source, housed in an identical container finished in black optical instrument enamel, and the photoelectric unit may extend up to 35 feet.

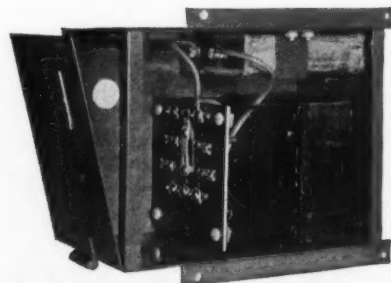
### Motorpump for Compact Installations

FOR use in compact installations such as the base of machines where height is restricted, the No. 205 Centrifugal Motorpump has been announced by Brown & Sharpe Mfg. Co., Providence, R. I. Like the No. 212 described in *M.D.*, January, p. 62, it is suitable for supplying coolant for machine tools and light machinery where dirt or abrasives may be present in the liquid, and where a moderate volume of flow is desired at a low head. Hydraulically balanced, the impeller is designed to allow abrasives to be discharged without excessive wear within the housing. The discharge pipe clears the motor.

### Varies Speed by Changing Voltage

A MULTI-STEP speed controller for alternating current motors, making possible the variation of motor speed by changing the input voltage,

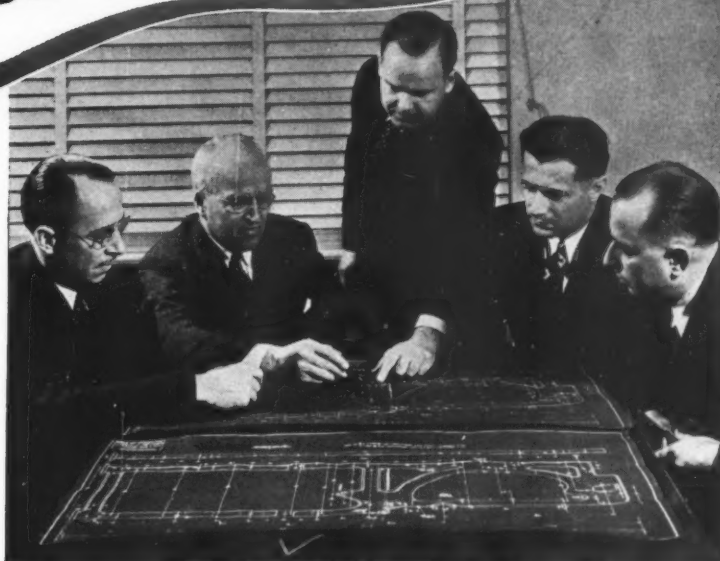
Speed controller  
for alternating  
current motors  
changes motor  
speed by vary-  
ing input voltage



is shown in the illustration. Made by Raytheon Mfg. Co., 132 Willow street, Waltham, Mass., this

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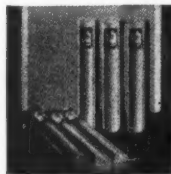


The Pease Planning Group . . . from Left to Right: H. J. Brunk, Chief Engineer; Thomas Lord, President; E. N. Nirison, Superintendent; W. E. Pashley, Vice President; A. F. Jacobs, Assistant Sales Manager.



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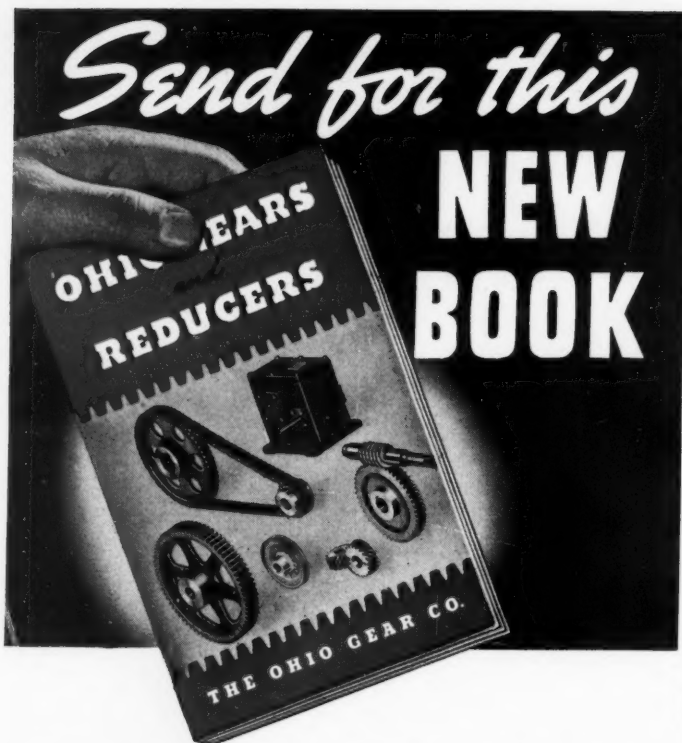


As for photographic arc lamps, we offer high speed, high quality, open flame Heli-O-Lite arc lamps in 7 individual types, as well as Super Actinic, high powered enclosed arc lamps in 5 individual types. Ask for our Photographic Arc Lamp literature.

And, finally, we hope you'll feel free to call us any time. Whenever we can put our 30 years experience . . . our engineering department . . . or our research department at your disposal, we shall be happy to do it.




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method of speed controls permits operation of a motor thermostat or automatic switch because it insures that the motor will restart, regardless of the controller setting. Principal components, as can be seen, are an auto-transformer with voltage adjustment taps and an oil-filled condenser. There are no moving parts.

### Guide Pin Covers with Felt Washers

A NEW development in guide or leader pin covers has been announced by Wiesman Mfg. Co., Fourth and St. Clair streets, Dayton, O. Felt washers have been incorporated in new models, a fea-

*Felt washers have been incorporated in guide pin covers, a feature desirable when it is necessary keep oil on the pins*

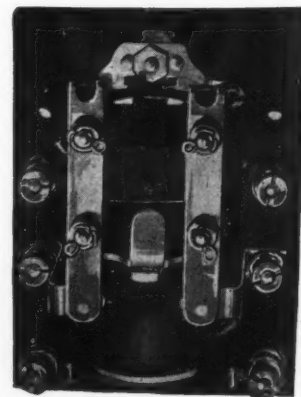


ture particularly desirable for automatic presses where it is necessary to oil the guide pins about every 30 minutes. This guide pin cover with a felt washer, when filled with a heavy lubricating oil, will require filling only about once every 100 hours.

### Small Reset Relays Announced

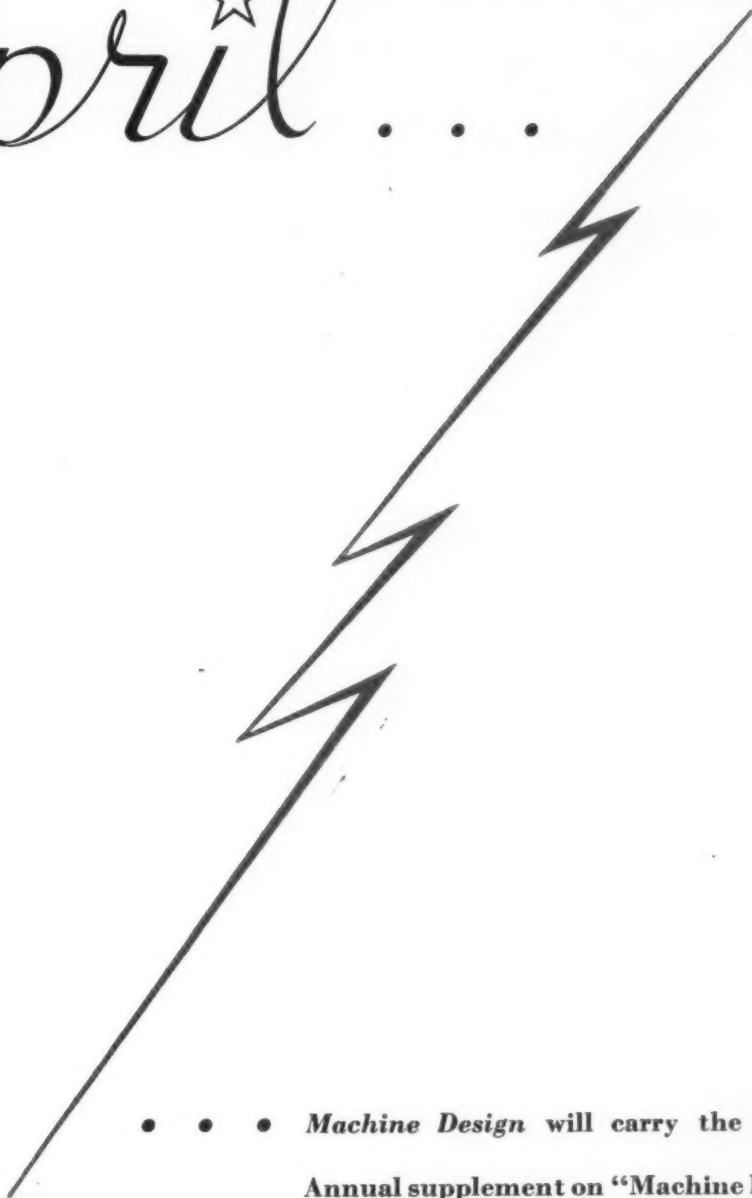
A NEW line of midget mechanical latch-in electrical reset relays has been placed on the market by Struthers Dunn Inc., Philadelphia. Made in both alternating current, 110 or 220 volts, 6 and

*Midget mechanical electrical reset relays have two coils, the lower latching the armature when energized, the upper releasing the latch*



3 amperes respectively, and in direct current, 115 volts, 1 ampere, the new relays are provided with two coils. When the lower coil is energized the

April...



• • • *Machine Design* will carry the Third Annual supplement on "Machine Drives and Controls". Full information on developments and new applications will be given. Concise yet complete presentation will bring engineering data files up-to-the-minute in usefulness.

**MACHINE DESIGN**

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LITERATURE**

armature picks up and latches in the energized position. Energizing the upper coil releases the latch allowing the armature to drop out. The relays are supplied with coils for either momentary or continuous duty, no power being required in the coil circuit to hold the armature in either position.

### Vertical Speed Reducer Announced

A NEW vertical differential speed reducer, No. 40 VM, has been announced by Winfield H. Smith Inc., Springville, N. Y. It has a standard flange type motor rated at 1½-horsepower, 1725

*A standard flange type motor rated at 1½-horsepower is used with vertical differential speed reducer*



revolutions per minute. Shaft of the motor is connected to the high speed shaft of the speed reducer by a flexible coupling. Heat treated alloy steel gears and shafts are used. Very compact, the reducer can be used with any make of motor.

### Motor-Pump Unit Developed

THE Motoair pump for vacuum or pressure offered by Motoair division of New Jersey Machine Corp., 1505 Willow avenue, Hoboken, N. J., requires no belts, gears, pulleys, sprockets or chains. It has an automatic visible oiling system, the supply of which can be seen at a glance in the cup reservoir. An integral unit, Motoair consists of a motor in various horsepower, pump, oil condenser and oiling system. Except for special applications, standard stock motors are used. Absence of moving parts is said to mean longer life, less upkeep. Motoair can be installed in various positions without affecting lubrication or power.

### Vernier Timers Need No Locking Device

VERNIER-SET timers, Series 2800, have been announced by Automatic Temperature Control Co., 34 East Logan street, Philadelphia. The time cycle, through use of the vernier principle, can be set accurately and maintained with no locking device. These timers are particularly suited for automatic

machinery. Type 2803, of the series, has four arrangements of load circuits, the desired one being selected by simple adjustment of two slides, movable to left or right, and by the location of bridge connections. These load circuit changes can be made easily without tools and without dismantling the timer. Fine silver contacts carry 30 amperes at 110 volts alternating current. All types, including 2803, are equipped with the Telechron motor.

### Magnet Wire Insulated with Resin

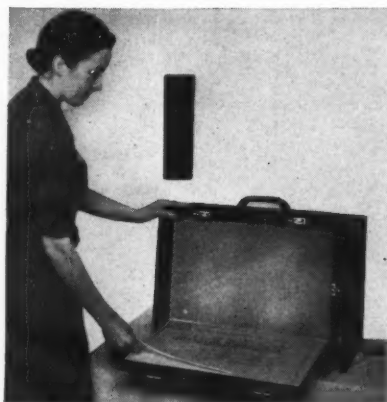
**F**ORMEX wire, a new magnet wire announced by General Electric Co., Schenectady, N. Y., is insulated with a tough, flexible synthetic resin. Need for bulky protective coatings is eliminated in many instances, thus offering the designer opportunities to reduce the size of many products. Formex wire can be severely twisted and subjected to a temperature of 125 degrees Cent. for an hour without cracking.

### Strip Heaters Resist Corrosion

**A** NEW line of strip heaters for operation at sheath temperatures as high as 1200 degrees Fahr. has been announced by General Electric Co., Schenectady, N. Y. The new heaters are enclosed in porcelain-enamel steel casings so that they have the additional advantage of resisting rust and corrosion. Not only are these new heaters more attractive in appearance but their first cost is lower. In offering more resistance to rust and corrosion, it is expected that the porcelain-enamelled units will substantially reduce replacement costs in heavy-duty applications.

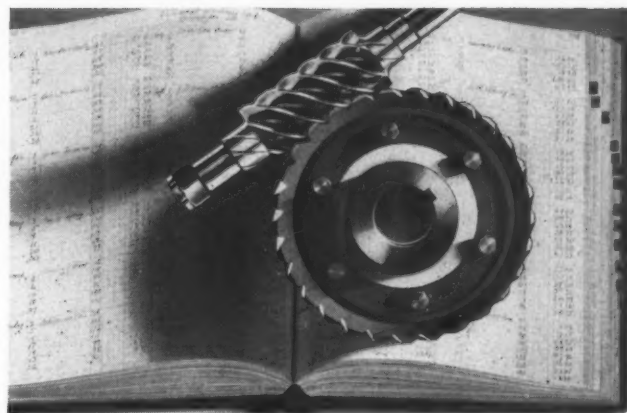
### Portable Blueprinter Put on Market

**T**HE Elpro portable blueprinting machine has just been put on the market by Electronic Products Mfg. Corp., 208 West Washington street, Ann Arbor,



*Approximately 5000 prints can be produced in the 100-hour life of the lamps in the Elpro portable blueprinting machine*

Mich. Measuring 22 inches long, 16 inches high, 11 inches deep, with shipping weight of 33 pounds, it



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operates on an ordinary power circuit—110-volt alternating or direct current. The light source consists of six special lamps with total wattage of 850. Approximately 5000 prints can be produced in the 100-hour life of the lamps. A highly polished aluminum reflector assures uniform light distribution over the field. In operation, the door shown in the illustration is opened and the printing paper is placed, yellow side up, on a substantial felt pad on the door's other side. The tracing is placed directly over the paper. When the door is closed, a light switch in the door frame is turned on for approximately  $1\frac{1}{2}$  minutes. Removed, the exposed print is placed in the developing cylinder, shown at left in illustration, for 2 or 3 minutes. The print is perfectly dry and ready for use when removed from the cylinder.

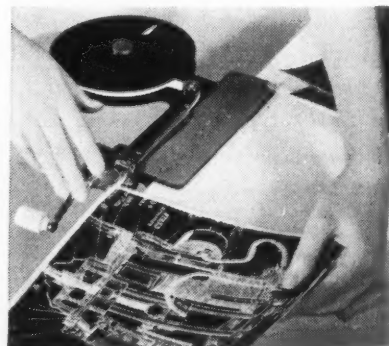
### Pencil Cloth Gives Clear Prints

UNDER the name Pencil-tex, the Frederick Post Co., P. O. Box 803, Chicago, has introduced a pencil drafting cloth. The velvety surface gives the cloth unusual affinity for pencils of all degrees of hardness. Even the hardest of pencils is claimed to leave a sharp, uniform line, and blueprints made from these pencil tracings are clear and "non-fuzzy."

### White Tape Protects Tracing Edges

EDGES of tracing and sketching paper are protected through use of the White Edger announced by David White Inc., 315 West Court street, Milwaukee. A special opaque white acetate fiber tape,  $\frac{3}{8}$ -inch wide, designed for this edging machine by

Special white acetate fiber tape is put on the edges of tracing and sketching paper by edging machine



the Minnesota Mining & Mfg. Co., Milwaukee, has an exact amount of adhesive on it and makes a permanent edge which will not curl or peel off. Heat from a blueprint machine will not affect the tape and many edged sheets can be filed together without danger of sticking. The machine is simply clamped on the edge of a table or desk and can be operated by anyone. Sheets which have been edged may be run through a continuous blueprint machine as often as desired without danger of the tape's adhering to the glass.

## Meetings and Expositions

### March 6-10—

**American Society for Testing Materials.** Regional meeting to be held at Deshler-Wallick hotel, Columbus, O. W. W. Heimberger, Buckeye Steel Castings Co., Columbus, is arrangements committee chairman.

### March 7-10—

**American Road Builders' association.** Thirty-sixth annual convention and show to be held in Civic Auditorium, San Francisco. Charles M. Upham, 914 National Press building, Washington, is managing director.

### March 8-9—

Air conditioning conference to be held at University of Illinois under sponsorship of department of mechanical engineering and the engineering experiment station of the College of Engineering.

### March 8-10—

**International Acetylene association.** Thirty-ninth annual convention to be held at Rice hotel, Houston, Tex. Additional information may be obtained from the association, 30 East Forty-second street, New York city.

### March 13-16—

**American Society of Bakery Engineers.** Annual meeting to be held at Edgewater Beach hotel, Chicago. Victor E. Marx, 1541 Birchwood avenue, Chicago, is secretary.

### March 14-16—

**American Railway Engineering association.** Annual meeting to be held at Palmer House, Chicago. W. S. Lachery, 59 East Van Buren street, Chicago, is secretary.

### March 14-18—

**American Society of Tool Engineers.** Annual meeting, and Machine and Tool Progress exhibition held at Convention Hall, Detroit. Ford R. Lamb, Room 428 Boulevard Temple building, 2567 West Grand boulevard, Detroit, is executive secretary.

### March 16-17—

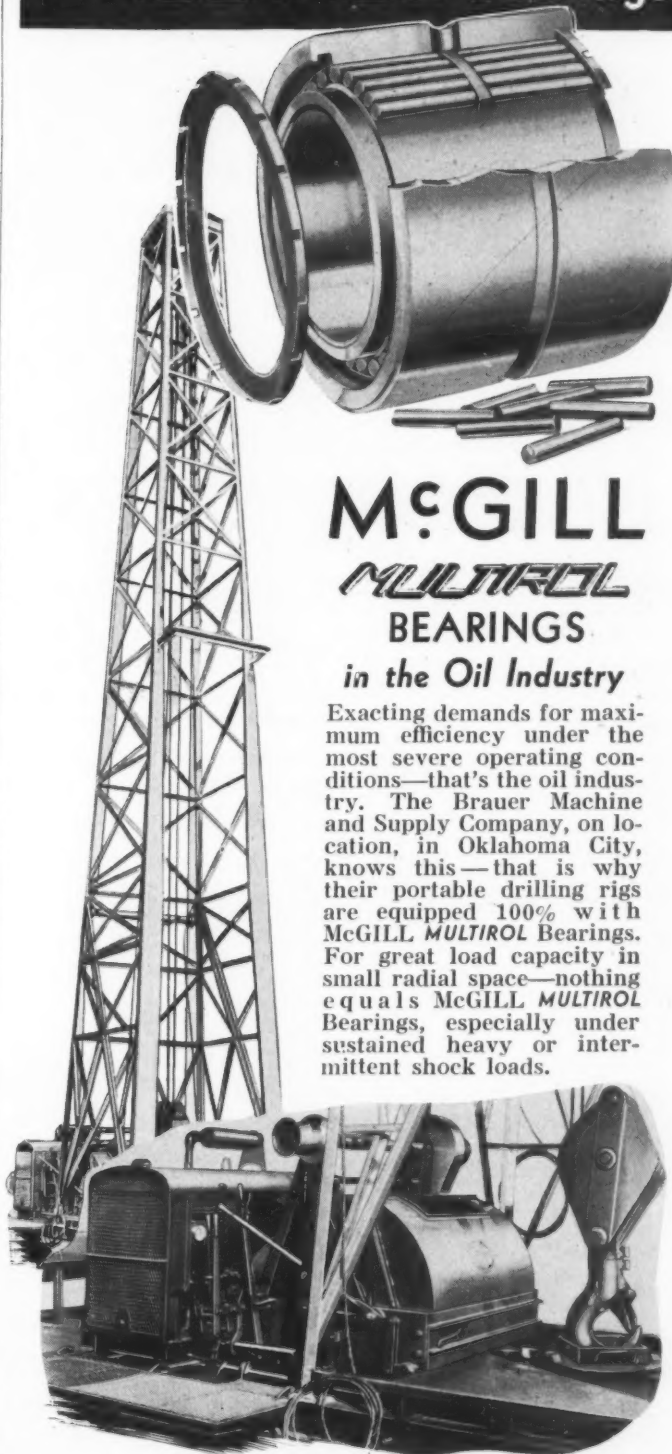
**Society of Automotive Engineers.** National aeronautic meeting to be held in Washington. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

### March 28-30—

**Society of Automotive Engineers.** First national

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—a handbook of springs and screw machine parts for designer, production manager and P. A.

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AND SCREW MACHINE PARTS  
The Peck Spring Co. 10 Wells St. Plainville, Conn.



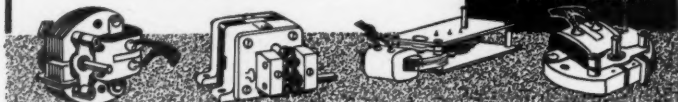
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passenger car meeting to be held at Hotel Statler, Detroit. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

April 13-15—

**Armour Institute of Technology**, with the co-operation of Iowa State College, Purdue university, State University of Iowa, Universities of Illinois, Michigan and Wisconsin, as well as local and national engineering societies, will hold Midwest Power Conference at LaSalle Hotel, Chicago. L. E. Grinter, Armour Institute of Technology, Chicago, is conference director.

May 15-18—

**American Foundrymen's association.** Annual convention to be held in Cincinnati. Arthur J. Tuscany, Tuscany, Turner & Associates, Penton building, Cleveland, is executive secretary.

May 22-24—

**American Gear Manufacturers' association.** Annual meeting to be held at Cavalier hotel, Virginia Beach, Va. J. C. McQuiston, 602 Shields building, Wilkesburg, Pa., is manager-secretary.

May 22-23—

**American Society of Refrigerating Engineers.** Annual meeting to be held at Hotel Hershey, Hershey, Pa. Additional information may be received from headquarters at 37 West 39th street, New York.

May 22-28—

**World Automotive Engineering Congress.** To be held in Hotel Pennsylvania, New York; at Indianapolis, May 29-30; at Hotel Statler, Detroit, May 31-June 2; and at Hotel Fairmont, San Francisco, June 6-8. Further information may be obtained from the Society of Automotive Engineers, 29 West Thirty-ninth street, New York.

May 25—

**American Iron & Steel institute.** General meeting to be held at Hotel Waldorf-Astoria, New York. Walter S. Tower, 350 Fifth avenue, New York, is executive secretary.

June 19-22—

**American Electro-Platers' society.** International convention to be held at Asbury Park, N. J. W. J. R. Kennedy, 90 Maynard street, Springfield, Mass., is executive secretary.

# MANUFACTURERS' publications

**ALLOYS (NICKEL)**—A new data sheet, "Iron-Nickel Alloys for Magnetic Purposes," section IV, No. 2 of the loose-leaf data book, "Nickel Alloy Steels," has been brought up to date by The International Nickel Co. Inc., New York. It describes these alloys for permanent magnets and also covers the high permeability alloys containing nickel.

**BEARINGS (BRONZE)**—Lubrite self-lubricating bearings and bushings, made of sand-cast bronze alloy, and related parts are described in bulletin No. 40 issued by Merriman Bros. Inc., 185 Amory street, Jamaica Plain, Boston. Types are illustrated and their features discussed. Second half of the book comprises engineering data aiding the choice of bearings and bushings.

**BRAKES (MAGNETIC)**—Bulletin No. 650 issued by Stearns Magnetic Mfg. Co., Milwaukee, describes the style DM magnetic disk brake.

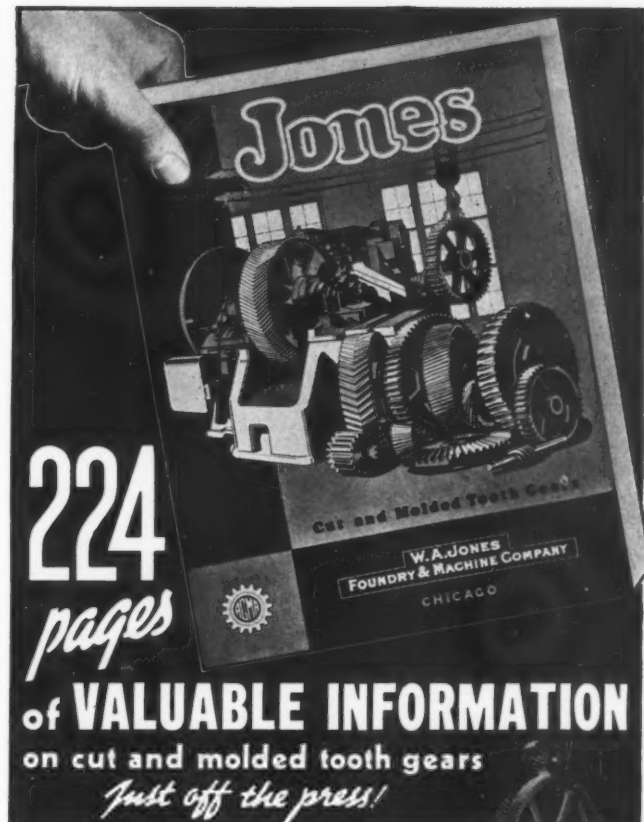
**CONTROLS (ELECTRICAL)**—Schaefer Bros. Co., 1059 West Eleventh street, Chicago, has published a new catalog containing information on its control apparatus, rheostats and resistors. Descriptions are augmented by photographs, specifications and price lists.

**CONVEYORS**—Of interest to designers of machines incorporating conveying systems or continuous flow production, a new book, "Natural Laws Applied to Production," has been issued in its third printing by Mathews Conveyer Co., Ellwood City, Pa. It sets forth the role of continuous flow of materials in industry and includes action photographs of conveyers in operation.

**FITTINGS**—A booklet entitled "New and Better Fittings for Small Welded Lines" has been issued by Crane Co., 836 South Michigan avenue, Chicago, discussing the new forged steel socket welding fittings introduced by the company. For designers, useful tables are presented showing the hydrostatic bursting pressures, tensile pull tests and working pressures. There are numerous photographs and drawings.

**GEARS**—A simplified analysis of the problem of rating high speed double helical gears is given in a reprint of a paper by A. Peterson, who originated the method used for the past 20 years in calculating these gears manufactured by the De Laval Steam Turbine Co., Trenton, N. J.

**INSTRUMENTS (THERMOMETERS)**—Catalog No. 1170 issued by C. J. Tagliabue Mfg. Co., Park and

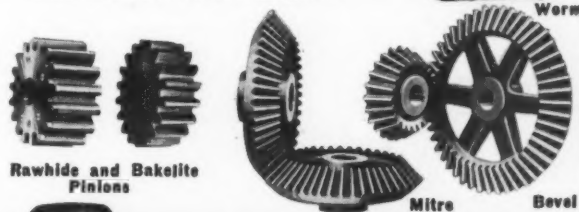


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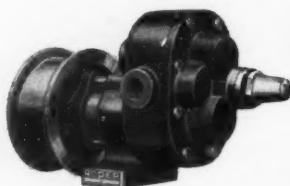
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Merrill and Walter H. James . . 3.50

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By C. W. Ham and E. J. Crane . . . 4.00

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Levi Thomas Wilson . . . . . 2.50

### Procedure Handbook of Arc Welding

Design and Practice . . . . . 1.50

Available from

**MACHINE DESIGN**

Penton Building, Cleveland, Ohio

Nostrand avenues, Brooklyn, N. Y., describes and illustrates dial-indicating thermometers of many types. Specifications are given along with pictures of typical installations.

**LUBRICATION**—The hand-operated lubricating system made by Bowen Products Corp., Auburn division, Auburn, N. Y., is described in catalog No. AF-74, just published. Photographs and detailed diagrams in color fully illustrate features of the system. New catalogs covering other types of the company's lubricating systems will be published soon.

**MOTORS**—Application data and price information on motors, generators, motor-generating sets, etc., is contained in the simplified motor price list and catalog No. 39 published by Diehl Mfg. Co., Elizabethport, N. J. The material is arranged for quick, easy reference. Color and illustrations add to the catalog's attractiveness.

**MOTORS**—Harnischfeger Corp., 4400 West National avenue, Milwaukee, has published illustrated bulletin C-4 describing its P&H direct current mill motors. Center of the folder is a two-page spread in color showing a cutaway view of the motor with design features clearly pointed out.

**MOTORS**—Lima Armature Works Inc., 438 North Main street, Lima, O., has published an illustrated bulletin in color covering its gear-shift motor for use with many types of machines requiring variable speeds.

**MOTORS, CONTROLS AND DRIVES**—Westinghouse Electric & Mfg. Co., East Pittsburgh, has issued the following new catalogs and leaflets discussing its products: Booklet B-2159, on geared drives for all types of industries; descriptive data 3610, on gearmotors of several reductions and horsepower ratings; booklet B-2164, on synchronous motors, including information on applications and typical torque requirements; descriptive data 3620, on types SH and DH speed reducers; instruction leaflet 2806, discussing the use and care of the type L-33 electrical interlock for alternating current; and booklet B-2131, describing combination linestarters consisting of the "De-ion" line-starter and circuit breaker.

**SPEED REDUCERS**—Three styles and 11 types of motorless speed reducers ranging in sizes from 1/20 to 7½-horsepower, are described in illustrated bulletin 22-33 published by Janette Mfg. Co., 556 West Monroe street, Chicago. Complete construction features, specifications, order instructions and prices are listed. Information on mounting and dismantling positions add to the book's value.

**SPEED REDUCERS**—Allis-Chalmers Mfg. Co., Milwaukee, has issued a new leaflet 2203-B on its compact self-contained gearmotor speed reducers for efficient low speed operation. This leaflet presents numerous line drawings and installation photographs showing typical gearmotor applications, and includes a table of ratings and speeds with 1750 revolutions per minute motors.



A reproduction of  
Model AC4 — 8 to  
16 H. P. engine  
with side mounted  
gas tank.

A complete line  
1 to 30 H. P.

**SAFE — DEPENDABLE POWER  
FOR ANY JOB — ANY CLIMATE**

Wisconsin Heavy-Duty  
Air-cooled Engines re-  
quire no "Fussing-with"  
or special attention. They  
take care of themselves.



**WISCONSIN**  
MOTOR CORP., MILWAUKEE, WIS.



INTERNAL GEARS  
WORMS  
RATCHETS  
SPURS BEVELS SPIRALS, ETC.

**For Precision Instruments, Machine  
Tools and Larger Machinery**

There's one way to get extra gear service in your machines—and that's to use Abart cut gears. Not only do Abart gears have longer life but they minimize replacements and give a longer profit by less maintenance of your machines. No stocks—made only to your specifications or B/P. Send us your specifications for estimate.

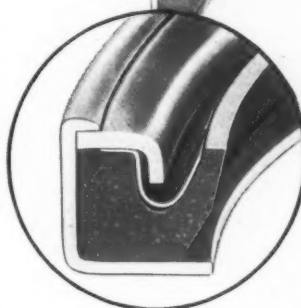
**SPEED REDUCERS** Many types and sizes in stock for immediate shipment. Write for catalog today.



**Abart**  
**GEAR AND MACHINE CO.**  
4821 WEST 16<sup>TH</sup> ST CHICAGO, ILLINOIS

**KLOZURE**

*Seals  
tight!*



**FOR SUPERIOR  
OIL SEAL  
PERFORMANCE**

AS a diver's helmet keeps water out and air in, for the protection of the diver—the Garlock KLOZURE keeps dust, dirt and water out and keeps oil and grease in, for the protection of bearings of all kinds. The exclusive KLOZURE sealing ring resists oil and heat, even at high temperatures; it does not become soft and flabby; gives superior oil seal performance. Write for catalog!



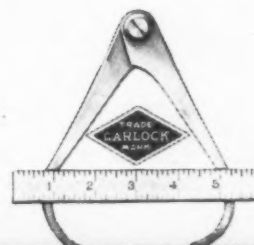
**SPLIT-KLOZURE**

To meet the need for an Oil Seal that can be installed around the shaft rather than over the end of the shaft, Garlock has developed the new patented SPLIT-KLOZURE. For all shafts of 3" diameter and larger.

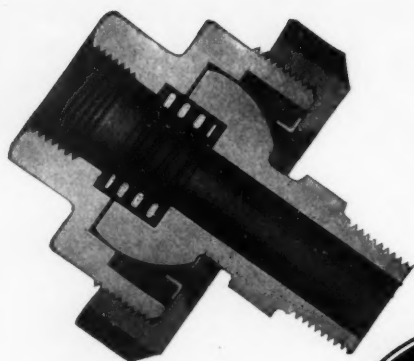
**THE GARLOCK  
PACKING  
COMPANY**

PALMYRA, N.Y.

In Canada: The Garlock  
Packing Co. of Canada Ltd.  
Montreal, Que.



**GARLOCK**



Swivel 7AS-8CS.

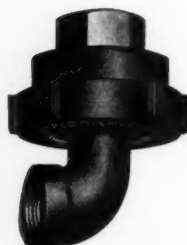


Swivel 7AS-8BS.



● Don't take chances on expensive shutdowns and production delays. Where pipe movement is involved, depend on BARCO joints to solve your problem.

**BARCO MANUFACTURING COMPANY**  
1813 Winnemac Ave., Chicago, Ill.



Swivel 7S-8BS



*Old Eagle Eye!*

D.O. James men have the training and knowledge to give an *Eagle Eye* supervision. This experience—and modern equipment—assures you worm gears and worm gear reducers that are most accurate—and will do the job!

Send for Catalog No. 150—180 Pages of Engineering Data, Weights and Prices on all Types and Kinds of Speed Reducers

**D.O. JAMES MANUFACTURING CO.**  
1120 W. MONROE STREET • ESTABLISHED 1888 • CHICAGO  
MAKERS OF ALL TYPES OF GEARS AND GEAR REDUCERS

## Business and Sales Briefs

**A**PPPOINTMENT of James L. Cawthon Jr. as development engineer has been announced by Malleable Founders' Society. The appointment is occasioned by a new activity of the society involving the furnishing of technical data to users of malleable castings, engineering of new uses for the material and other services to users of malleable castings.

Revere Copper & Brass Inc. has appointed Keith C. Bowers, formerly of the company's St. Louis office, as sales representative in Western Missouri and Kansas, with headquarters at 325 Ward Parkway, Kansas City, Mo.

M. H. Jewett, with headquarters at Room 301, Union building, 1836 Euclid avenue, Cleveland, has been appointed district representative for the Northern Ohio territory by the American Flexible Coupling Co., Erie, Pa.

A tract to house a new building for the company's Chicago headquarters has been purchased by General Electric Co. Work will soon be started on the building which will provide space for the company's sales offices, warehouse and service shop.

R. F. Jackson has been made manager of mechanical sales of the Baltimore branch office of the mechanical goods division of U. S. Rubber Co. Heretofore this office was under supervision of the Philadelphia branch, but now will operate independently.

Since 1916 Pittsburgh district manager of Electric Controller & Mfg. Co., Cleveland, A. C. Dyer has been made general sales manager, with headquarters in Cleveland.

Electro-Alloys Co., Elyria, O., has appointed John R. Heckman as midwestern representative, with headquarters at 122 South Michigan avenue, Chicago.

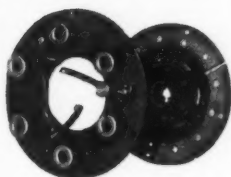
Robert B. Ellison has been made president of the Ellison Bronze Co., Jamestown, N. Y. C. F. Oliver Ellison was appointed secretary and A. C. Nordstrom, vice president and treasurer.

Announcement has been made of the appointment of the Industrial Sales & Engineering Co., 3118 North



"Proved Very Satisfactory"

## ROCKFORD Spring-Loaded Clutch Suits ARIENS-TILLER



"Rockford Clutches have proved very satisfactory in Ariens-Tillers. They give us the smooth engagement and load carrying capacity required in our unit and we are entirely satisfied in having selected this clutch for our machine." The Model A tillage combine, pictured, uses an 8½" Rockford Spring-Loaded Clutch in the main drive for its generally ideal characteristics and especially the close-coupled feature. Rockford Clutches are made in 6" to 20" sizes, 2 to 80 h.p. at 100 r.p.m., single or double drive plates, oil or dry operation. Write today for information.

### PULLMORE CLUTCHES

Made in single and double types; Pullmore Clutches are unexcelled for applications requiring a compact, powerful multiple disc clutch.

**ROCKFORD DRILLING MACHINE DIVISION**  
Borg-Warner Corporation, 304 Catherine Street, Rockford, Illinois

## LEIMAN BROS. NEW SURFACE GRINDER DUST COLLECTOR

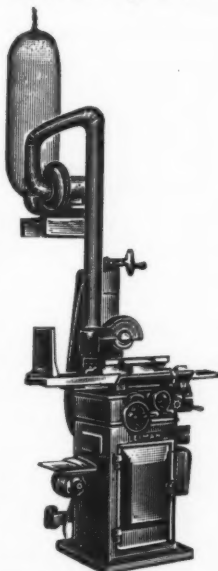
*For Your Grinder of Whatever Make*

**A Complete  
Motor-Driven Unit  
at Small Cost**

This small, yet powerful, machine occupies but 11" x 13" space. It consists of a sturdy, powerful suction blower, electrically driven, with piping connections to the surface grinder and to the high grade dust disposal bag.

It can easily be placed on the floor or a shelf on a nearby pillar or wall, out of the way. It can be plugged into any lamp socket.

The strong suction of air draws away all the light metallic and light abrasive dust created when grinding. This highly irritating dust is caught



in a bag made of specially treated filter cloth which may be quickly emptied when necessary.

**Don't Breathe  
Grinding Dust!**

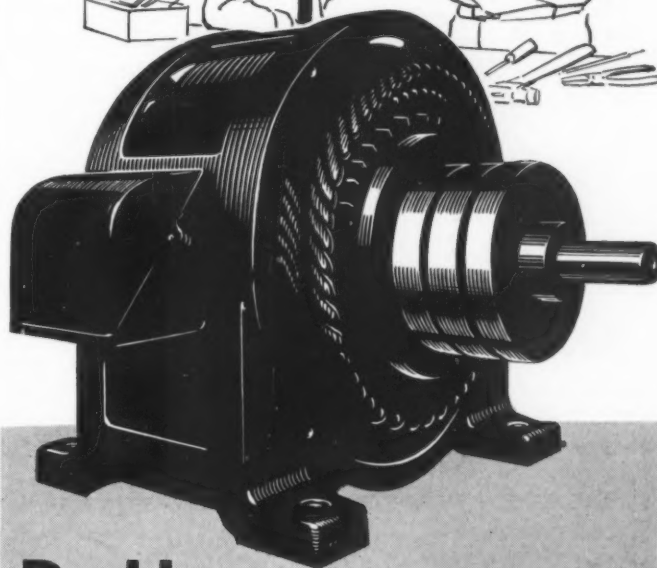
"The direct cause of silicosis is the inhalation of minute particles of silica dust. While the type of pulmonary lesion depends on the particular dust inhaled, the underlying pathological principle is the same in all forms of the disease, viz., an ultimate fibrosis and replacement of the elastic lung tissue by a hard unyielding fibrous tissue."

**SILICOSIS IS  
INCURABLE!**

**GET FREE INFORMATION AND FOLDER  
ABOUT THE DANGERS OF DUST**

**LEIMAN BROS., Inc.,** SG23-P WALKER ST.  
NEW YORK CITY  
**MAKERS OF GOOD MACHINERY FOR 50 YEARS**

# EXPERIENCE



## P&H HIGH EFFICIENCY ELECTRIC MOTORS

Through more than fifty years, this organization has practiced true craftsmanship in building electric motors for many special purposes. Unhurried production, faithful attention to detail and the use of only the best materials are responsible for the outstanding manner in which P&H electric motors meet the most severe demands for service. If you use motors it will pay you to investigate. Address the Harnischfeger Corporation, 4556 West National Avenue, Milwaukee, Wisconsin.

*Convertible Slip-Ring and Squirrel-Cage Motors  
up to 125 h.p. capacities. Literature on request.*

**HARNISCHFEGER  
CORPORATION**

MOTORS • HOISTS • WELDING ELECTRODES • ARC WELDERS • EXCAVATORS • ELECTRIC CRANES

Broad street, Philadelphia, as district sales representative for the Southeastern Pennsylvania, New Jersey and Eastern Maryland territory of American Flexible Coupling Co., Erie, Pa.

Re-election of Robert W. Wolcott as president of Lukens Steel Co., Coatesville, Pa., was recently announced. Other officers re-elected are: Charles L. Huston, first vice president; F. H. Gordon, vice president in charge of sales; and D. S. Wolcott, vice president.

F. E. Blackburn has become associated with the Ohio Ferro-Alloys Corp., Canton, O. sales department as sales engineer.

Laminated Shim Co. Inc., Long Island City, N. Y., celebrated its twenty-fifth anniversary some weeks ago.

Recent elections of H. G. Alexander as board chairman and Herbert P. Ladds as president and director have been announced by the National Screw & Mfg. Co., Cleveland. Mr. Alexander is resigning as president of Sweet's Steel Co., Williamsport, Pa.

Several changes in personnel have recently been announced by Plaskon Co., Toledo, O. These are: Richard B. Harrison, vice president, has been placed in charge of the Toledo sales office, and Whiting N.

Shepard, formerly in charge of the Toledo sales office, has been made head of the sales and service in the Chicago area, assisted by G. T. Walker Jr. Carleton Ellis Jr., until now in charge of the Chicago office, has been transferred to Toledo.

E. Clay Howell has been appointed as vice president and general manager of Haven Malleable Castings Co., Cincinnati.

Previously general sales manager, E. E. LeVan has been elected vice president of Haynes Stellite Co., and is located at the company's general office and works at Kokomo, Ind.

Identified for more than twenty years with the chain industry, D. Robert Coutts has become associated with International Chain & Mfg. Co., York, Pa. His new position is that of western sales manager and he will be located at 2109 South Wabash avenue, Chicago.

Another announcement by the Plaskon Co. is that a new office in Rochester, N. Y., at 1045 Lincoln-Alliance Bank building, has been opened, in charge of C. Burton Wing who will handle sales and service in that territory. A. E. Egerter has moved to Toledo, into the sales and advertising department of the company. H. W. DeVore with headquarters in Toledo, will supervise sales and service for Ohio and Michigan.



**They used to say**  
**"STRONG AS AN ELEPHANT"**  
*... but now they say,*  
**"IT'S STRONG AS**  
  
**SOCKET SCREWS"**

Because strength is a primary requisite in socket screws, we have steadily adapted the stronger, tougher alloys to our needs and have at the same time developed more improved methods of heat treating. All this assures "Unbrako" Products being tops in tensile strength and hardness. You just can't do better than specify "Unbrako" all the time. Send for Samples, Prices and Details.



Fig. 232  
"Unbrako"  
Hollow Set  
Screw.



Pats. Pend.  
Fig. 1434  
Knurled "Unbrako"  
Socket  
Head Cap Screw

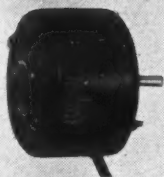
**STANDARD PRESSED STEEL CO.**

BRANCHES	JENKINTOWN, PENNA.	BRANCHES
BOSTON		CHICAGO
DETROIT		ST. LOUIS
INDIANAPOLIS	BOX 102	SAN FRANCISCO

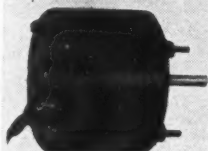
# VICTOR

*Super-Power*

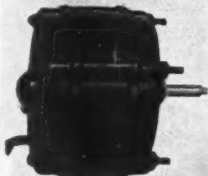
# MOTORS



MODEL M41



MODEL M35



MODEL M6

## SHADED POLE . . . . . . Induction Type

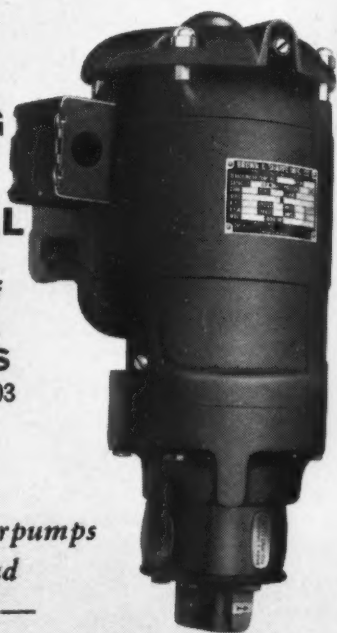
Victor offers an outstanding line of quality-built motors of fractional power ranging from 1/200 to 1/10 H. P. Ideal for such applications as fans, blowers, animated displays, timing devices, etc. Years of successful motor building — equipped to solve difficult engineering problems. Write for literature today!

**Manufacturers' Representatives:**  
*A few territories not yet assigned.  
If interested, write us at once.*

**VICTOR ELECTRIC PRODUCTS, INC.**  
845 Reading Road Cincinnati, Ohio

## VERTICAL MOUNTING - - as well as HORIZONTAL

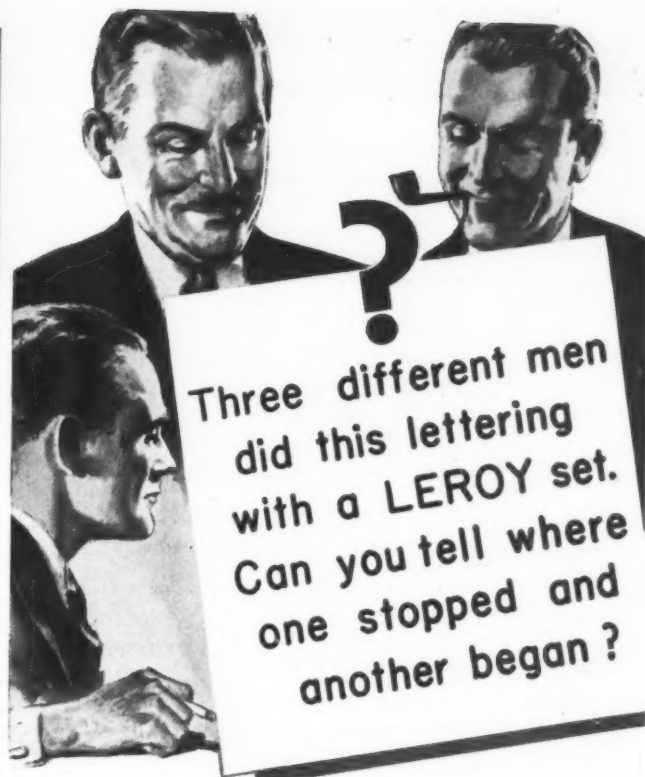
in the 3 sizes of  
**Rotary Geared  
MOTORPUMPS**  
Nos. 101, 102 and 103



— Specify Motorpumps  
for Flexibility and  
Economy. Write —

**Brown & Sharpe Mfg. Co.**  
Providence, R. I., U. S. A.

**BROWN & SHARPE  
PUMPS**



Three different men  
did this lettering  
with a LEROY set.  
Can you tell where  
one stopped and  
another began?

Here is a lettering technique which produces accurate, *uniform* lettering—with speed and ease. No guide lines, no preliminary roughing in. Complete, finished letters are formed in one operation.

A Leroy set consists of patented templates, a simple scribe and foolproof, tubular pens. Each template produces both vertical and slanting letters and numerals. The work is performed well above the template, in full view of the operator; there is no danger of smearing when the template is removed.

There are templates and pens of all sizes—sold singly or in sets. You make your selection to fit your own standards and requirements. Prices are moderate.

Add Leroy lettering to your drafting room equipment. Your K & E dealer will be glad to arrange a demonstration—or write us for Booklet No. 59 and price list.

## K & E LEROY

REG. U.S. PAT. OFF.

## LETTERING SETS



**KEUFFEL & ESSER CO.**

EST.  
1867

NEW YORK • HOBOKEN, N. J.  
CHICAGO • ST. LOUIS • SAN FRANCISCO • DETROIT • MONTREAL

## NEW MACHINES— And the Companies Behind Them

(For illustrations of other outstanding machinery  
see Pages 46-47)

### Agricultural

"Clipper" combine, Massey-Harris Co., Racine, Wis.  
Tractor and plow, Minneapolis-Moline Power Implement Co.,  
Minneapolis.

### Air Conditioning

"Packaged" air conditioners, York Ice Machinery Corp., York,  
Pa.  
Room air circulator, Ad-Lee Co., Chicago.

### Bakery

Automatic slicer, Micro-Westco Inc., Bettendorf, Ia.  
Progressive or staggered bread slicer, Bakery Machinery Corp.,  
Milwaukee.

### Canning

Tomato scalders, A. K. Robins & Co. Inc., Baltimore.  
Corn trimmer, The Sinclair-Scott Co., Baltimore, Md.  
Jar closing machine, E. W. Bliss Co., Brooklyn, N. Y.

### Confectionery

Ice cream batch mixer, Cherry Burrell Corp., Chicago.  
Refrigerated cabinets, Kold-Hold Mfg. Co., Lansing, Mich.

### Construction

Packer-head pipe machine, Concrete Pipe Machine Co., Sioux  
City, Pa.  
Block press, Kent Machine Co., Cuyahoga Falls, O.  
Vibrator-stripper, Multiplex Concrete Machinery Co., Elmore, O.  
Portable bulk-cement plant, Heltzel Steel Form & Iron Co.,  
Warren, O.  
Traction-driven road sweeper, Frank G. Hough Co., Chicago.  
Sand spreader, Hercules Motor Corp., Canton, O.  
Compressor, Schramm Inc., West Chester, Pa.  
Mixers, Ransom Concrete Machinery Co., Dunellen, N. J.  
Heavy-duty combination grinder and crusher, Prater Pulver-  
izer Co., Chicago.  
Concrete mixers, Chain Belt Co., Milwaukee.

### Dairy

Cottage cheese filling machine, Filler Machine Co., Philadelphia.  
Automatic rotary filler and capper, Specialty Brass Co.,  
Kenosha, Wis.  
Cabinet cooler, Cherry Burrell Corp., Chicago.  
Cold raw milk filter, Stamsvik Co., Pittsburgh.

### Domestic

Refrigerator, Gale Products, Galesburg, Ill.  
Automatic electric roaster, Miracle Products Inc., Chicago.

### Finishing

Automatic polishing and buffing machine, Packer Machine Co.,  
Meriden, Conn.  
Semiautomatic spray coating machine, Eclipse Air Brush Co.  
Inc., Newark, N. J.

### Metalworking

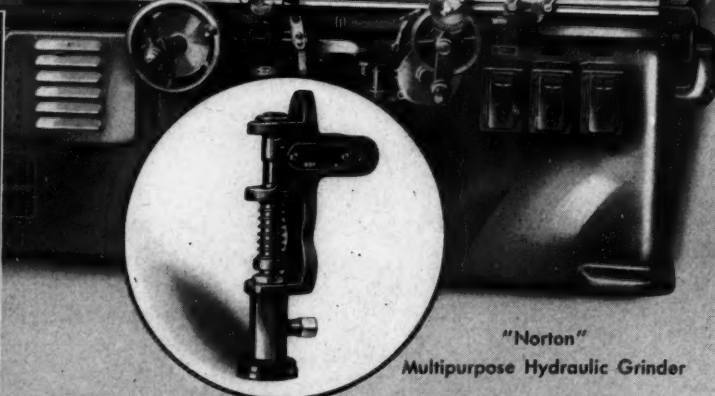
Marking machine, Geo. T. Schmidt Inc., Chicago.  
Cable armoring machine, Sleeper & Hartley Inc., Worcester,  
Mass.  
Contour grinder, Stanley Electric Tool Div., New Britain, Conn.  
Hydraulic press, Southwark Div., Baldwin-Southwark Corp.,  
Eddystone, Pa.  
Milling machine, Brown & Sharpe Mfg. Co., Providence, R. I.  
Feeding and straightening unit, F. J. Littel Machine Co.,  
Chicago.  
High-speed, precision, tool-room lathe, Hardinge Bros. Inc.,  
Elmira, N. Y.  
Unit head type drilling machine, G. A. Gray Co., Cincinnati.  
Sheet metal former, Engineering and Research Corp., River-  
dale, Md.  
Cut-to-length shear, Cleveland Punch & Shear Works Co.,  
Cleveland.  
High-speed press, V & O Press Co. Inc., Hudson, N. Y.  
All-purpose die-cutting band saw, Continental Machines, Inc.,  
Minneapolis.  
Heavy-duty, bench-type grinder, Diehl Mfg. Co., Elizabethport,  
N. J.  
Disk grinders, Gaston Power Tool, Evergreen Park, Ill.

### Printing

Heavy-duty autoshaver, Wood Newspaper Machinery Corp.,  
Plainfield, N. J.  
Continuous suction stream feeder, Christiansen Machine Co.,  
Racine, Wis.  
Glider, Hammond Machinery Builders Inc., Kalamazoo, Mich.  
Miterer, Craftsman Machinery Co., Boston.  
Driller-slotter, Challenge Machinery Co., Grand Haven, Mich.  
Printer-slotter, F. X. Hooper Co. Inc., Glenarm, Md.  
Saw trimmer, Milwaukee Saw Trimmer Corp., Milwaukee.  
Electric proofpress, Vandercook & Sons, Chicago.

## Safeguards ALL TYPES of bearings!

The correct  
oil film  
to each  
individual  
bearing...  
*automatically*



"Norton"

Multipurpose Hydraulic Grinder

# BIJUR

AUTOMATICALLY *Correct* LUBRICATION

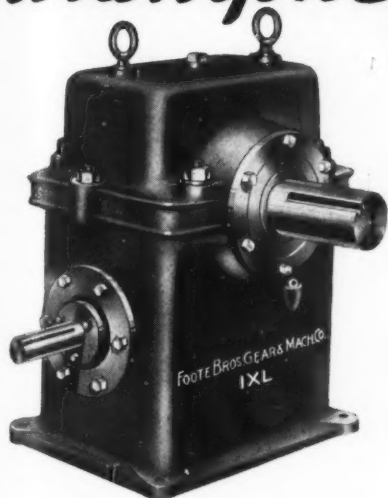
This machine is lubricated by a con-  
tinuous film of clean oil metered to  
bearing surfaces of the table ways—  
in proportion to speed and extent of  
slide travel. Varying requirements of  
lubrication are met each instant... no  
mechanical adjusting necessary. Bijur  
equipment built into your machine will  
lubricate... correctly, unfailingly, auto-  
matically... any number of bearings  
of all types and sizes. Dismisses lubri-  
cation uncertainties!

Ask about BIJUR for your machines.

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LONG ISLAND CITY NEW YORK

1097

# When you Specify IXL Speed Reducers



The Trademark is Your Guarantee  
of Dependability



## FREE: IXL Handbook



664 pages cram full of valuable gear and technical data. Free to engineers, designers and executives. Write for your copy.

### IXL Products

Complete line of speed reducers, powered gears, special drives and gears of all types to fit any requirements.

THE IXL trademark is recognized throughout industry as a Mark of Quality. Behind this Mark of Quality stands an organization, the success of which for over 77 years has rested upon its ability to live up to that trademark. Such a background cannot be discounted. You can specify "IXL" Speed Reducers, confident that they are designed and built to give the utmost in dependability

**FOOTE BROS.**  
GEAR & MACHINE CORPORATION  
5303 So. Western Blvd., Chicago

## POSITIONS

AVAILABLE OR WANTED

**WANTED:** Mechanical designer, experience on heavy paper box machinery preferred. State experience, training and general qualifications, also salary expected. Eastern location. Address Box 114, MACHINE DESIGN, Penton Building, Cleveland, Ohio.

**WANTED:** Mechanical engineer with ability to develop and qualify as assistant chief engineer. Age 35 to 45, with design experience in connection with relatively heavy equipment comparable to paper working machinery. Shop experience or contact that provides background and familiarity with shop practice in connection with design, is very important. Opportunity for permanent career with long established company manufacturing widely known line of machinery. Reply giving full details of education and experience to Box 115, MACHINE DESIGN, Penton Building, Cleveland, Ohio.

CLASSIFIED advertisements are set in eight point Stymie bold face type, approximately eight words to a line. Rates are as follows:

Positions Available—20c a word, with a minimum charge of \$10.00, which permits the use of fifty words.

Positions Wanted—10c a word, with a minimum charge of \$3.00, which permits the use of thirty words.

The box number will be counted as one line or eight words.



Briggs & Stratton 4-cycle, air-cooled motors set the standard, the world over, by which gasoline motor performance is judged . . . Full range of models, for every application requiring from 1/2 to 5 h. p.

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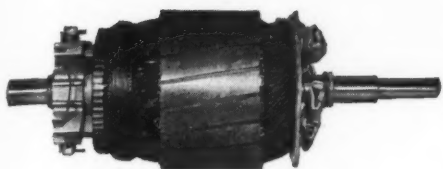
\*Advertisements appear in previous issues.

# MACHINE DESIGN



# CHECK THESE FEATURES *of* Wagner Motors

**Rotor**



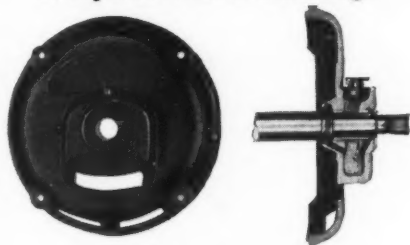
✓ All Wagner rotors are dynamically balanced to insure freedom from vibration. Rotor slots are skewed and combined with careful electrical design to insure a motor with a minimum of magnetic noise. Rotor shaft is designed to carry mechanical overloads without perceptible deflection.

**Stator**



✓ Wagner stators are known for their strength and rigidity, in addition to their mechanical simplicity. Stator coils are well insulated and securely wedged in place. Stator core and windings are thoroughly impregnated with heavy insulating varnish and carefully baked in drying ovens to drive out all moisture. Frame is of rolled steel—strong, rigid, will not get out of alignment.

**Endplates and Bearings**



✓ Concentrically machined endplates and diamond-bored bearings—insure true alignment of bearings, perfect centering of shaft, and uniform airgap. Oil wells are roomy—hold large quantity of oil-soaked wool yarn which carries an uninterrupted supply of filtered oil to all bearing surfaces.

**Base Construction**



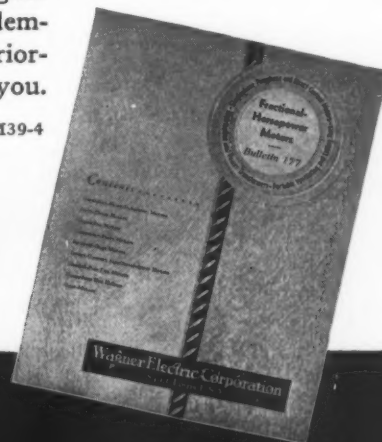
✓ Wagner fractional-horsepower motors can be equipped with either rigid-mounted base, resilient-mounted base, or flanged or machined endplate mounting. Bases are formed from steel plate and are of electric-welded construction. Mounting slots are so spaced as to permit interchangeability of motors of the same frame size.

There are many other details about Wagner fractional-horsepower motors that should be of interest to engineers and manufacturers of motor-driven machinery and appliances. Wagner welcomes an opportunity to demonstrate their features of superiority that will prove useful to you.

M39-4



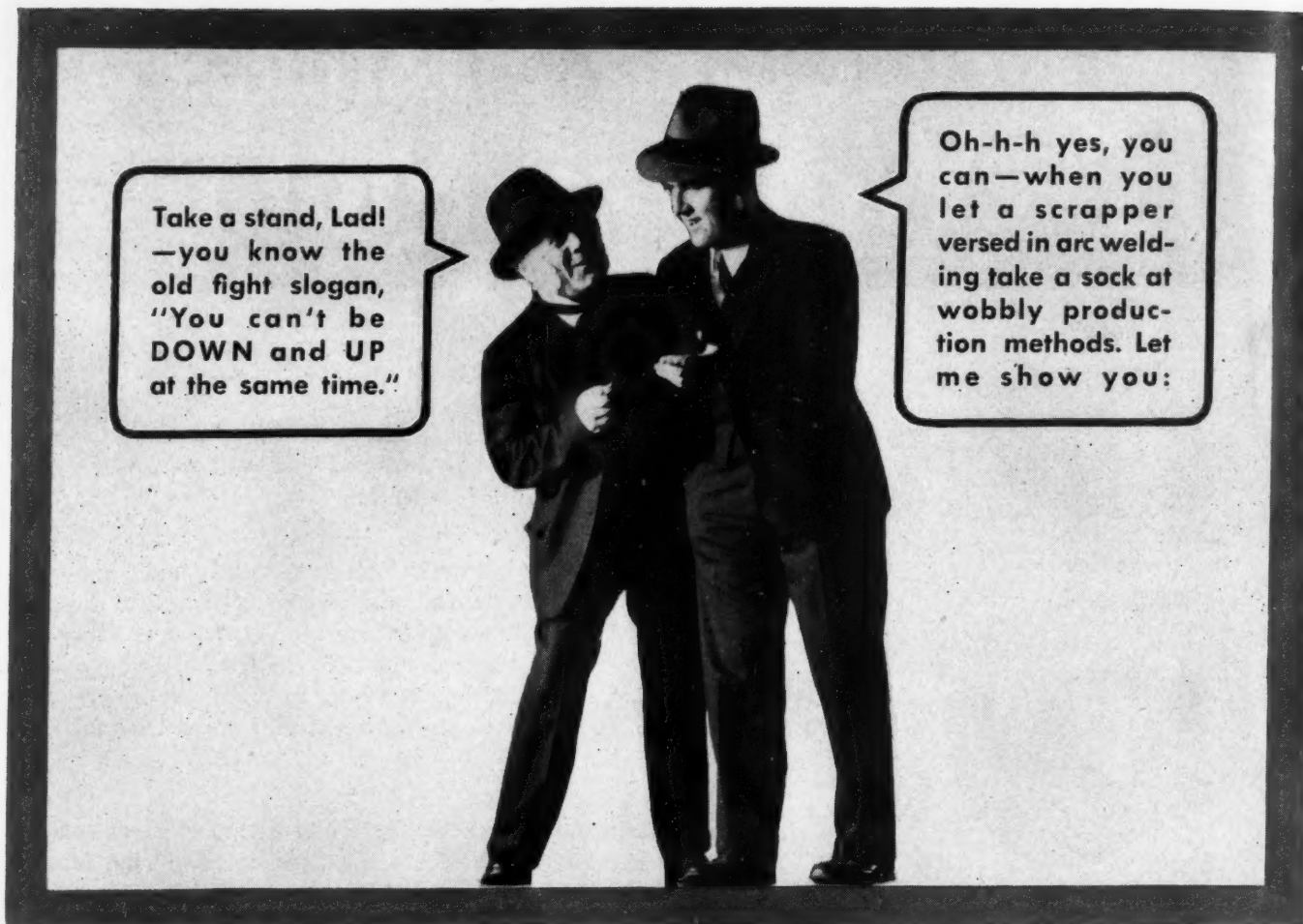
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Wagner Fractional-Horsepower Motors



**Wagner Electric Corporation**

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## HOW TO DRIVE COSTS DOWN AND QUALITY UP

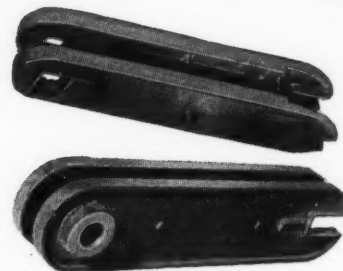
● "Take the case of a manufacturer of textile machinery in Patterson, N. J. Over a 1-year period they reduced the cost of a scouring machine 47% and doubled its production, largely because they had in their organization a man of authority with a Zest for welding. His function is Profit Crusader because he drives costs DOWN and quality UP



through his crusade for welding. By putting such a leader in charge of welding development and production, hundreds of companies have benefited in this way:

"Manufacturing operations are centralized and simplified. Products are made stronger, stiffer, lighter and of more pleasing appearance. Delivery time is shortened. Service economy is increased. *Everybody profits.*

"In most plants, the Profit Crusader works on a part-at-a-time basis. It's simple. For example, take this sprocket housing for a weaving machine. The former construction, shown at the top, occasionally broke in service. The P. C. took steel plate, flat bar, pipe spacers and a machined hub and built the part shown at



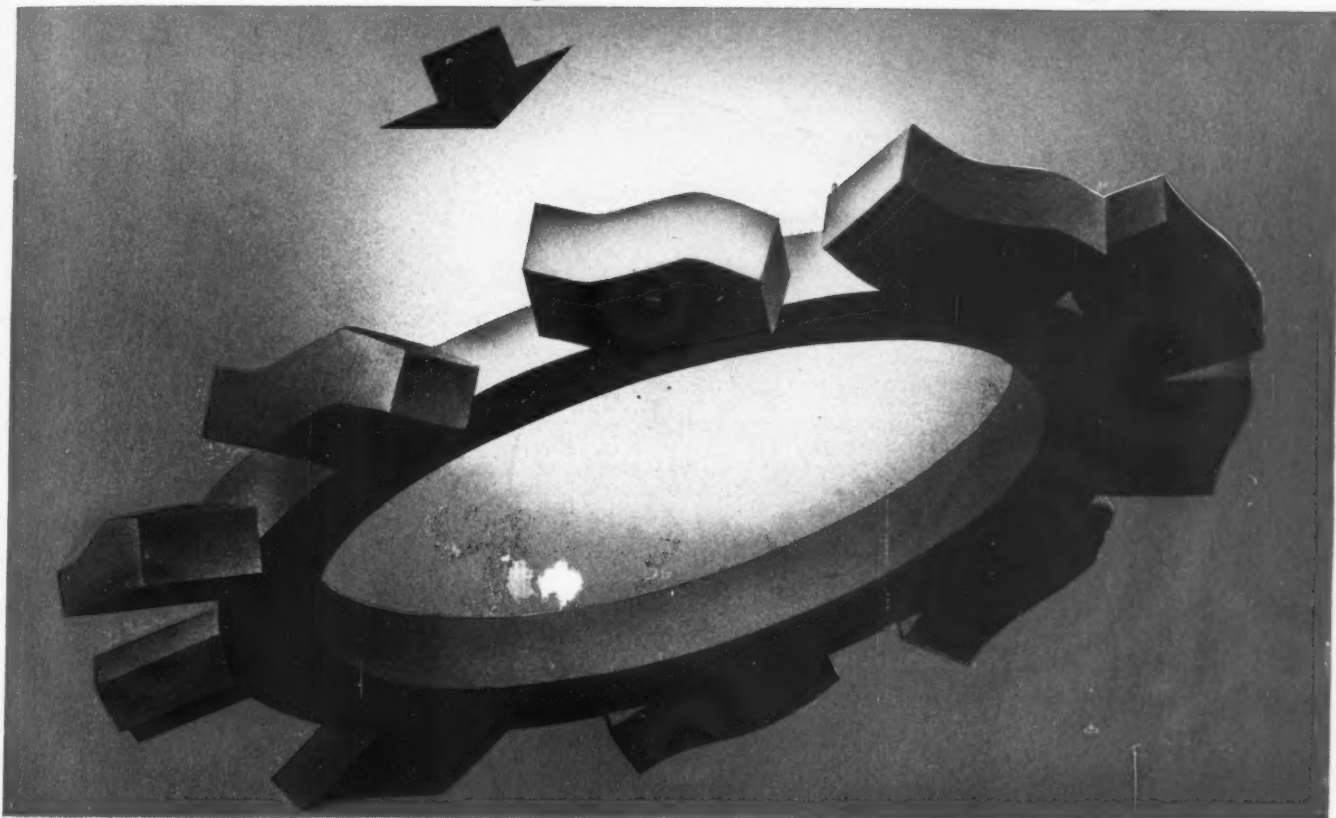
the bottom. It costs \$8.70 less, weighs 20% less and is unbreakable. Costs are DOWN—quality UP.

"As I said before, all that's needed to get this economy rolling is to appoint a man with a welding Zest . . . and by Zest I don't mean a vest with a zipper. Consult Lincoln."

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WHEN WASTED—KEEP IT WHERE IT  
BELONGS WITH "PERFECT" OIL SEALS**

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Chicago Rawhide "Perfect" Oil Seals keep lubricant in the bearing where it will do the work—keep grit and moisture out.

Not expensive—"Perfect" Oil Seals are easy to handle and install. They need no servicing. They save many times their cost in lubricant and in bearing maintenance and replacement, each year.

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